

LMSC F060784/3
NOVEMBER 1985

Space Station Human Productivity Study

FINAL REPORT VOLUME III REQUIREMENTS

CONTRACT # NAS9-17272
DISE-1093T

PREPARED FOR
MAN-SYSTEMS DIVISION
NASA Lyndon B. Johnson Space Center

BY

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(NASA-CR-135687) SPACE STATION
HUMAN PRODUCTIVITY STUDY. VOLUME 3:
REQUIREMENTS Final Report
(Lockheed Missiles and Space Co.)
390 p

N93-70450

Unclass

29/54 0126315

FOREWORD

This document is Volume III of the Space Station Human Productivity Study Final Report, performed under NASA-JSC contract NAS9-17272. The complete set of volumes for this final report consists of:

Volume I	-	Final Report (Study Description)
Volume II	-	Executive Summary (and Oral Review)
---> Volume III	-	Requirements
Volume IV	-	Issues
Volume V	-	Management Plans

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INTRODUCTION

STUDY BACKGROUND

The Space Station Human Productivity Study, under NASA contract NAS9-17272, was conducted to review and evaluate existing data to develop requirements for design and operations in order to directly support Space Station Crew Performance. The enclosed requirements are the result of this effort and have undergone several reviews and revisions under the NASA management of Dr. James L. Lewis, Study Technical Manager, Johnson Space Center (1). The review process was supported by NASA offices with expertise in the respective topical areas (2). In order to permit a meaningful definition of many requirements it was necessary to make critical assumptions about the design, operations, or Space Station Program events. These assumptions are identified, herein, with the related requirements.

The data search disclosed many areas for which information is insufficient for adequate definition of desired requirement statements. In these cases, one of three alternatives was taken: a) a broad or "top level" requirements statement was made, based on available knowledge; b) a more specific statement was made, including a "TBD" to indicate the data gap; or c) no statement at all was made, to avoid potential confusion. The former two types of requirement statements are italicized to identify them as topical areas for which special studies will be pursued. Asterisked footnotes on each requirements page explain the status of these unresolved requirements.

The unresolved requirements were synthesized into study topics called Issues. The Issues underwent comprehensive reviews by a combined NASA-contractor team (3) in order to assess priorities and to compare with ongoing or planned studies being done by NASA. Issue studies not already covered by NASA will be performed according to priorities of importance and timely impact on the Space Station Program. Study performance Management Plans were generated to support that effort. As the studies are completed, revisions to this document will be published in order to replace unresolved with completely defined requirements. As the process comes to an end, there may be remaining unresolved requirements for which studies have not been conducted. These will be identified and decisions made either to delete them or to resolve in other ways.

Figure 1 summarizes the study and follow-on scheme.

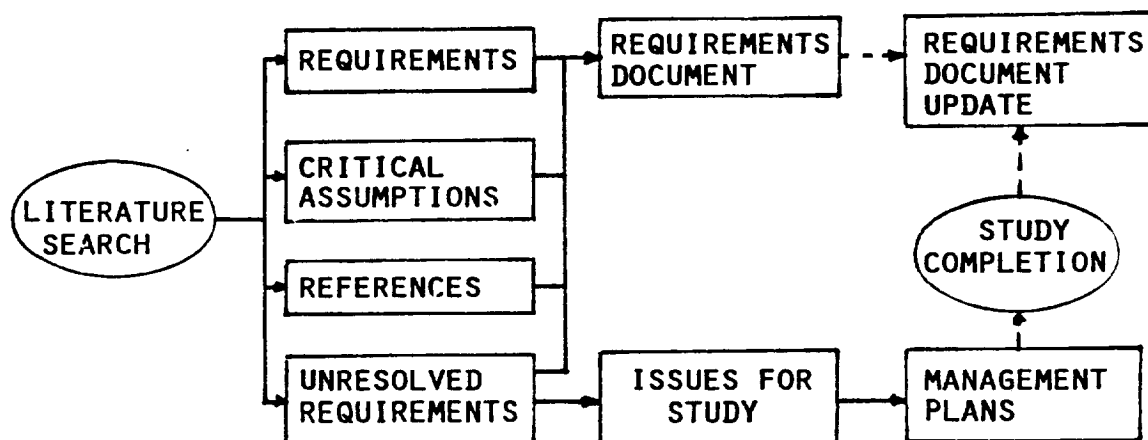


Fig. 1 Overview of the HP Study Requirements Development Approach

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USE OF THIS DOCUMENT

Each requirement page is headed by distinguishing titles and accompanying numbers (see Figure 2). In this case, Interior Architecture is the heading of Group One. The Element is Traffic Flow, number 102 or Element two under Group One. Frequency of Transit is the first Subelement: 10201. The first requirement (-01) is in italics and has a TBD in the statement indicating that the need to design traffic routes to accommodate frequency is recognized but the actual frequency is unknown.

All Requirements are specified against Subelements, so that the Subelement Listing is useful as a topical index. A copy of the listing follows this introduction.

REPORT FORMAT 3.1		DESIGN/OPERATIONS REQUIREMENTS	
1	INTERIOR ARCHITECTURE	GROUP	
102	TRAFFIC FLOW	ELEMENT	
10201	FREQUENCY OF TRANSIT	SUBELEMENT	
CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)			
Revised: 9/23/85			
REQUIREMENTS		REFER. NO.	
-01	<i>*(Traffic routes shall be designed to consider frequency of use and the best combinations of uses of the volumes considered for the specific traffic route.)*</i>	132(C-4,	2.2.10.1,
			(g)01b)
-02	Flow patterns shall minimize the distance large masses are transported and reduce as much as possible the congestion caused by large masses transported through tight areas.	135(p 12,	2.1.2)
-03	Habitability accommodations & facilities shall be designed to the 0-g neutral body posture, traffic patterns, congestion avoid cleaning and ease of maintenance.	132(C-4,	2.2.10.1)

Figure 2. Requirements pages are headed by Group, Element and Subelement. Italics requirements are subject to further study for final definition.

SCOPE AND ORGANIZATION

The scope of this study covers IVA and interface with EVA. A separate study, "Advanced EVA System Design Requirements Study" (RFP 98E2-72-4-37P), addresses EVA systems and interface with IVA. That study, awarded to three contractors, will generate certain of the IVA/EVA Interface requirements and issues. Because the technical interface with the EVA Study contractors could not be completed for this study, all requirements pertaining to IVA/EVA Interface, Group 5 are designated "Preliminary."

The Space Station functional Elements affecting human productivity are divided into five Groups: 1. Interior Architecture, 2. Crew Support, 3. Crew Activities, 4. IVA Systems, and 5. IVA/EVA Interface. Each group is divided into Elements, e.g., General Layout, Traffic Flow and Decor are Elements of Group one. Elements are subdivided in Subelements, e.g., Frequency of Transit, Equipment Accommodations, and Passage Impingement are Subelements of the Element, Traffic Flow.

Many of the IVA Subelements contain requirements of interest to EVA concerns. For example, contingency operations may require temporary EMU-suited entry to modules. A requirement concerning appropriate clearance is included under Subelement 10102, "Activity Volume per Crewmember/Function," within IVA Interior Architecture. Such IVA Subelements which include EVA system concerns are identified by an asterisk on the Subelement List.

A decision was made for the man-tended mode within this study to assume that the man-tended station will consist of an unpressurized lab module. There are significant impacts on Human Productivity requirements (and Issues) as a result of this Critical Assumption. Those requirements are not valid if a different Critical Assumption is made. This primary assumption led to definition of other associated Critical Assumptions, all of which are listed within the listing of System Level Critical Assumptions.

The Subelement numbering scheme is designed to ease the assessment of the latter impact. Please refer to the Subelement List. All man-tended Subelements have been grouped under a Man-Tended Element, 55XXX. The Subelement three-position codes repeat corresponding IVA Group element numbers. For example, Subelement 55101 is "Man-Tended General Layout" (Element 101 is General Layout within IVA Interior Architecture); 55303 is "Man-Tended Maintainability" (Element 303 is Maintainability within IVA Crew Activities).

SYSTEM LEVEL CRITICAL ASSUMPTIONS:

A set of System Level Critical Assumptions were defined to act as a baseline reference point for all requirements. For example, it was assumed that at manned Initial Operating Capability (IOC), the crew is composed of six members. Unique assumptions, needed to provide a context for specific subelement requirements, are listed on the individual subelement requirement format. (See below) If any of these Critical Assumptions should change with the evolution of the Space Station Program, one or more requirement statements within a Subelement may require modification.

REFERENCES:

The spectrum of data resources which was consulted for the study is very large. Those references which provided a direct bearing on requirement statements are cited. Each requirement has a corresponding cross reference to the numbered entry on the Reference List.

DESIGN/OPERATIONS REQUIREMENTS:

Requirements are listed by Subelement pages. The top of each page identifies the code number and title of the Group, the Element and the Subelement, corresponding to the Subelement List, which begins on Page 7.

o CROSS REFERENCE TO RFP PARAGRAPH NO:

Reference paragraph numbers are provided as appropriate. In some cases the respective paragraph numbers are shown under the Reference column, corresponding to specific requirement statements.

o Revision:

The current revision date of each subelement Requirement page is shown.

o REQUIREMENTS:

(In order to facilitate traceability, line item numbers have been retained through reviews and evaluation of the present requirement statements. As a result, many line numbers are intentionally omitted.)

Defined Requirements are listed as shown. No order of priority is intended.

Unresolved Requirements are highlighted by the use of italics and surrounding asterisks. TBDs are included to indicate specific study needs. (See asterisk footnote at the bottom of the form.) No order of priority is intended.

o REFERENCE NUMBER:

The primary reference source(s) for each requirement is listed in this column, using the item number from the Reference List. Entries in parentheses indicate appropriate chapters, sections, pages, etc.

o CANDIDATE SOLUTIONS:

In many cases, candidate solutions are offered as alternative solutions, only, and do not convey a NASA sanction. Also, they in no way preclude identified study needs. Where a candidate solution pertains to a specific requirement, the corresponding line item number is assigned. The GEN entry indicates the candidate solution is generic to the Subelement or relates to a subset of requirements.

o CRITICAL ASSUMPTIONS:

If one or more requirements for a Subelement are dependent on a critical assumption, these are described. Any change in the assumption may necessitate a change in one or more requirements within the Subelement.

As the defined Issues become resolved, updates to this requirements document will be available. In the interim, appropriate NASA standards and references should be used.

Questions on this material should be directed to:

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SUBELEMENT LIST

(GROUP
ELEMENT
SUBELEMENT)

1 INTERIOR ARCHITECTURE

101 GENERAL LAYOUT

- * 10102 ACTIVITY VOLUME PER CREWMEMBER/FUNCTION
- 10104 DEDICATED VS MULTIPURPOSE SPACE UTILIZATION
- * 10106 EQUIPMENT & FURNISHING REQUIREMENTS
- 10107 PHYSICAL/FUNCTIONAL ADJACENCIES
- 10108 INTER/INTRA-MODULE EQUIPMENT ORIENTATION
- * 10109 GROWTH

102 TRAFFIC FLOW

- 10201 FREQUENCY OF TRANSIT
- * 10202 EQUIPMENT ACCOMMODATIONS
- 10203 CONGESTION MINIMIZATION
- * 10204 PASSAGE IMPINGEMENT
- 10205 EMERGENCY EGRESS/INGRESS
- * 10206 CREW/EQUIPMENT TRANSLATION & HANDLING AIDS

103 DECOR

- 10301 COLOR, TEXTURE, GRAPHICS & LIGHTING
- 10302 INTERIOR DESIGN MODIFIABILITY
- 10303 CODING

104 MATERIALS

- 10400 GENERAL
- * 10401 HEALTH AND SAFETY
- * 10402 MAINTENANCE AND REPAIR
- 10403 DURABILITY & SUSCEPTABILITY TO DAMAGE
- 10404 AUDITORY, OLFACTORY & TACTILE EFFECTS
- 10405 ELECTROMAGNETIC PROPERTIES

105 ANTHROPOMETRY

- * 10501 POPULATION CHARACTERISTICS
- * 10502 RANGE OF ACCOMMODATION
- * 10503 PHYSICAL DIMENSIONS & LIMITS IN MICRO-G

106 MODULARITY

- * 10601 GENERAL
- * 10603 EXISTING STANDARDS AND CONVENTIONS
- * 10605 MAINTAINABILITY SUPPORT
- * 10607 GROWTH

107 WINDOW/REMOTE VIEWING

- 10701 VIEWING REQUIREMENTS
- 10702 WINDOW OPTICAL CHARACTERISTICS
- * 10703 WINDOW CONFIGURATION
- 10704 WINDOW ACCESS
- * 10705 WINDOW LOCATION AND NUMBER
- * 10706 WINDOW MAINTENANCE/PROTECTION
- * 10707 INDIRECT VIEWING OPTIONS

109 STOWAGE/STORAGE

- 10901 CREW EQUIPMENT STOWAGE

10902 FOOD/GALLEY STOWAGE EQUIPMENT
10903 TRASH-WASTE STOWAGE/STORAGE
10904 DATA FILE STOWAGE
10905 STOWAGE VOLUME CONFIGURATION
10906 GROWTH

2 CREW SUPPORT

201 INTERNAL ENVIRON

* 20101 ATMOSPHERE REVITALIZATION
* 20102 WATER MANAGEMENT
20103 CONTAMINATION/ODOR CONTROL
20107 GROWTH

202 EXTERNAL ENVIRON

* 20201 RADIATION - PARTICLES
* 20202 TRAPPED PROTONS
* 20203 TRAPPED ELECTRONS
* 20204 HIGH-Z, HIGH-E PARTICLES
* 20205 SOLAR FLARES
* 20206 ULTRAVIOLET/INFRARED
* 20208 MICROMETEOROIDES
* 20210 GROWTH
* 20212 GROUND SUPPORT

203 INDUCED ENVIRON (Int/Ext)

* 20302 ELECTROMAGNETIC
* 20304 LASER
* 20305 GROWTH

204 AREA LIGHTING

* 20401 ILLUMINATION & DISTRIBUTION REQUIREMENTS
* 20402 GLARE CONTROL
* 20403 FIXTURES/LUMINAIRES
* 20404 CONTROLS
* 20405 GROWTH

205 ACOUSTICS

* 20501 NOISE CONTROL
* 20502 PHYSIOLOGICAL EFFECTS
* 20503 PSYCHOLOGICAL EFFECTS
* 20504 FUNCTIONAL TASK/WORK AREA ENVIRONMENTS

206 SAFETY

* 20601 CREW SAFETY

207 HEALTH MAINTENANCE

* 20701 PHYSIOLOGICAL CONDITIONING/COUNTERMEASURES
* 20702 PHYSIOLOGICAL STATUS MONITORING
* 20703 DISEASE PREVENTION
* 20704 ACCIDENT PREVENTION
* 20705 STRESS MANAGEMENT

208 MEDICAL CARE

20801 DIAGNOSIS & TREATMENT
20804 MEDICAL RECORDS, COMM, & INFO MGMT
20805 GROWTH

- 209 RECREATION
 - 20901 TYPES
 - 20902 FACILITIES
 - 20903 EQUIPMENT
 - 20904 SUPPORT
 - 20906 PLANNING
- 210 PERSONNEL HYGIENE
 - 21001 BODY WASTE MANAGEMENT
 - 21002 WHOLE-BODY CLEANING
 - 21003 PARTIAL-BODY CLEANING
 - 21004 BODY GROOMING
 - 21005 GROWTH
- 211 FOOD/WATER SYSTEMS
 - 21101 MENU
 - 21103 FOOD PACKAGING
 - 21104 FOOD DISPENSING
 - 21105 FOOD PREPARATION
 - 21106 FOOD SERVING
 - 21107 FOOD CLEAN-UP
 - 21108 POTABLE WATER
 - 21109 GROWTH
- 212 HOUSEKEEPING
 - 21201 CONTAMINATION
 - 21202 CLEANING EQUIPMENT
 - 21203 TASKS
 - 21204 SCHEDULES
 - * 21205 CLOTHES WASHER/DRYER
 - 21206 DISHWASHER
- 213 WASTE/TRASH MANAGEMENT
 - 21301 TRASH GENERATION
 - 21302 TRASH COLLECTION
 - 21303 TRASH SORTING
 - 21304 MICROBIAL STABILIZATION
 - 21305 WASTE/TRASH TRANSFER
 - 21306 VOLUME REDUCTION
 - 21307 WASTE/TRASH DISPOSAL
 - 21308 GROWTH
- 214 SUPPLY SUPPORT
 - * 21401 RESUPPLY REQUIREMENTS
 - * 21402 INVENTORY MANAGEMENT AND CONTROL
 - * 21404 TRANSPORTATION AND HANDLING
 - * 21407 PRESERVATION, PACKING & PACKAGING
- 215 RESTRAINT SYSTEMS
 - 21501 FOOT RESTRAINTS
 - 21502 BODY RESTRAINTS
 - 21503 EQUIPMENT RESTRAINTS
 - 21504 SLEEP RESTRAINTS
 - * 21505 PORTABLE RESTRAINTS
 - 21506 HANDHOLDS
- 216 MOBILITY AIDS
 - 21601 INSTALLED EQUIPMENT
 - 21602 PORTABLE GEAR

- 217 COMMUNICATIONS
 - * 21701 SYSTEMS
 - * 21702 LOCATIONS
 - * 21703 FUNCTIONAL TYPES
 - * 21705 RECORDKEEPING
 - * 21706 NONNORMAL COMMUNICATIONS
- 218 QUALITY ASSURANCE
 - * 21801 PROCEDURES VERIFICATION
 - * 21802 CONDITION VERIFICATION
 - * 21803 CONTROL
 - * 21804 EQUIPMENT CALIBRATION/CERTIFICATION
 - * 21805 ANOMOLY INVESTIGATION, ANALYSIS & EVALUATION
 - * 21806 REPORTING AND RECORDING
 - * 21807 DETECTION, ISOLATION AND IDENTIFICATION
- 219 CLOTHING
 - 21901 IV CLOTHING (UNDERWEAR AND OUTERWEAR)
 - 21903 GROWTH
- 220 VIBRATION
 - * 22001 VIBRATION CONTROL

3 CREW ACTIVITIES

- 301 CREW TRAINING
 - 30101 TRAINING METHODS
 - 30102 TRAINING DEVICES & MEDIA
 - 30103 TRAINING LOCATION
 - 30105 TRAINING FOR ORGANIZATIONAL EFFECTIVENESS
 - 30107 GROWTH
- 303 MAINTAINABILITY
 - * 30301 ACCESSIBILITY
 - * 30302 COMMONALITY
 - * 30303 MAINTAINABILITY HARDWARE CHARACTERISTICS
 - * 30304 TESTABILITY/DIAGNOSTICS
 - * 30305 ORU DEFINITION/CONFIGURATION
 - * 30306 MAINTAINABILITY AIDS
 - * 30307 CREW SKILLS
 - * 30308 GROWTH
- 304 MAINTENANCE
 - * 30401 MAINTENANCE CONCEPT
 - * 30402 SCHEDULED MAINTENANCE TASKS
 - * 30403 UNSCHEDULED MAINTENANCE TASKS
 - * 30404 TECHNICAL DOCUMENTATION
 - * 30405 CUSTOMER SCHEDULED MAINTENANCE TASKS
 - * 30406 CUSTOMER UNSCHEDULED MAINTENANCE TASKS
 - * 30407 CUSTOMER TECHNICAL DOCUMENTATION
- 305 SUPPORT EQUIPMENT
 - * 30501 FUNCTIONAL LIMITATION
 - * 30502 COMMONALITY/STANDARDIZATION
 - * 30503 ARRANGEMENT
 - * 30504 LOCATION
 - * 30505 IDENTIFICATION/LABELING

306 ACTIVITY PLANG/SCHEDG
* 30601 DUTY CYCLES
* 30602 JOB ROTATION
* 30603 SCHEDULING METHODS

307 MAN-MACHINE ROLES
* 30701 MAN-MACHINE ROLE
* 30702 GROUND MAN-MACHINE ROLES
* 30703 GROWTH

308 ORGANIZATION
30801 ORGANIZATIONAL STRUCTURE
30802 METHODS TO ENHANCE COMPATIBILITY

309 STATION AUTONOMY
* 30901 AUTONOMY
* 30903 GROWTH

4 IVA SYSTEMS

401 WORKSTATIONS
* 40101 WORKSTATION DEFINITION
* 40102 WORKSTATION GENERAL REQUIREMENTS
* 40103 WORKSTATION UNIQUE REQUIREMENTS
40104 PORTABLE WORKSTATION

402 DATA MANAGEMENT
* 40201 GENERAL DATA MANAGEMENT
40203 OPERATING SYSTEM
40205 MEMORY CAPABILITY
* 40206 INTERFACE COMPATIBILITY
40207 MAINTENANCE/REPAIR
40209 APPLICATION PROGRAMS

5 IVA/EVA INTERFACE

501 AIRLOCK
50101 SYSTEMS
50102 FUNCTIONAL/PERFORMANCE REQUIREMENTS
50103 HYPERBARIC
50104 EVA SUPPORT
50105 MAINTAINABILITY
50106 MATERIALS PROCESSES
50107 COMMONALITY
50108 SAFETY/TRAINING

** 502 SERVICING AREA

** 503 SUPPLY SUPPORT

504 STOWAGE/STORAGE
50401 EMU EQUIPMENT
50402 EEU EQUIPMENT
50403 RESTRAINTS/TETHERS/EVA TOOLS
50404 EMU/EEU SERVICING & CHECKOUT EQPT. STORAGE
50405 MAINTENANCE & REPLACEMENT PARTS

50406 PAYLOAD SUPPORT EQUIPMENT STOWAGE
50407 GROWTH

** 505 ATMOSPHERE

506 PERSONNEL HYGIENE
50601 IN-SUIT BODY WASTE MANAGEMENT
50602 SUIT HYGIENE

507 TRAINING/PROCEDURES
50701 GENERAL

** 508 COMMUNICATIONS

** 509 DATA MANAGEMENT

55x MAN-TENDED
55101 GENERAL LAYOUT
55102 TRAFFIC FLOW
55103 DECOR
55104 MATERIALS
55105 ANTHROPOMETRY
55106 MODULARITY
55107 WINDOWS/REMOTE VIEWING
55109 STOWAGE/STORAGE
55201 INTERNAL ENVIRONMENT
55202 EXTERNAL ENVIRONMENT
55203 INDUCED ENVIRONMENT
55204 AREA LIGHTING
55205 NOISE & VIBRATION
55206 CREW SAFETY
55213 WASTE/TRASH MANAGEMENT
55214 SUPPLY SUPPORT
55215 RESTRAINT SYSTEMS
55216 MOBILITY AIDS
55217 COMMUNICATIONS
55218 QUALITY ASSURANCE
55301 CREW TRAINING
55303 MAINTAINABILITY
55304 MAINTENANCE
55305 SUPPORT EQUIPMENT
55306 ACTIVITY PLANNING AND SCHEDULING
55307 MAN-MACHINE ROLES
55309 STATION AUTONOMY
55401 WORKSTATIONS
55402 DATA MANAGEMENT

* IVA Subelements having Requirements and Issues of concern to EVA Systems.

** Requirements generated by Advanced EVA Systems Design Requirement Study.

SYSTEM LEVEL CRITICAL ASSUMPTIONS

1. Space Station, Manned, is as described in Phase B RFP Reference Configuration, with crew of six. See JSC-19989, Aug. 84.
2. Phase B Milestones are:

CSD	19 April 85
RUR #1	3-19 July 85
RUR #2	4-18 Oct 85
IRR	3-17 Jan 86
SRR	7-21 Mar 86
ISR	1-15 Jul 86
SDR	17 Nov - 1 Dec 86
EOC	18 Jan 87
ATP - Phase C/D	18 Apr 87
PDR	18 Apr 88
CDR	18 Apr 90
3. EMU suited access within the modules will be only for regaining an environment for safe IVA entry, e.g., for leak repair and ECLS system (pressure, contamination control) repair in any habitable module. Minimal depressurized entry may also be required at module depressurization for growth, ie., attaching additional modules.
4. Space Station, Man-Tended, is as described in Phase B Reference Configuration (See 7th paragraph, page 5 of JSC-19989) and RFP page C-5-11, para 2.4.
5. The Man-Tended station (Lab module) is non-pressurized. (This critical assumption is relevant only to Subelements 55XXX.)
6. Man-Tended operations will be supported by an STS crew living on the shuttle.
7. The Man-Tended module will be reoutfitted for manned IOC. (Requirements do not incorporate considerations for conversion to a pressurized module.)

Because the man-tended module will be pressurized the IVA requirements within Groups 1 through 4 are applicable to both man-tended and nominal options. Section 55XXX is applicable to non-pressurized work areas.

NOTE:

1. The Requirements of 55XXX do not apply if the man-tended module(s) is pressurized. I.e., the 55XXX Requirements were written for unpressurized conditions during man-tended operations.
2. If the man-tended module(s) is pressurized those Requirements in Groups 1 through 4 should be utilized as applicable.

GLOSSARY

ACGIH	American Conference of Government & Industry Hygienists
AF	Air Force
AI	Articulation Index
ANSI	American National Standard Institute
ASE	airborne support equipment
ATAC	Advanced Technical Advisory Committee
BP	blood pressure
C	centigrade
C&T	communications & tracking
CAD	computer aided design
CCTV	closed circuit television
CDG	Configuration Design Guidelines
CO2	carbon dioxide
CRT	cathode ray tube (TV screen)
CSD	contract start date
CVD	cardiovascular deconditioning
db	decibels
dBA	decibel, A scale
dBC	decibel, C scale
DBMS	database management system
E-Field	electric field
ECG	electrocardiogram
ECLS	environment control life support
ECLSS	environmental control & life-support system
EEU	extravehicular excursion units
EL	electro-luminescent
EM	electromagnetic
EMI	electromagnetic interference
EMU	extravehicular mobility unit
EVA	extravehicular activity
F	fahrenheit
Ft-C	foot candles
Ft-L	foot lamberts
+GZ	positive acceleration gravity vector, head to foot (least tolerance)
H-Field	magnetic field
H2O	water
HEPA	high efficiency particulate air
HMF	health maintenance facility
HMS	habitability manned system
HOL	higher-order language
HPD	hearing protection device
hr	hour
HR	heart rate
HZ	hertz
HZE	high energy Z particles
IDMS	Space Station information & data management system
IMS	inventory management system
IMSS	in-flight medical support system
IOC	initial operating capability
IR	infra-red
ISO/TC	International Standards Organization/technical circular
IV	intravenous
IVA	intravehicular activity
JSC	Johnson Space Center
k	kilo
K	Kelvin

GLOSSARY

LA	noise level in dBA
LCD	liquid crystal display
LED	light emitting diode
LET	linear energy transfer or ionization rate along particle track
LSRM	Life Sciences Research Module
Leq	equivalent noise level (average over a specified duration)
MDBMS	medical database management system
MIL-STD	military standard
MMU	manned maneuvering unit
MPAC	multipurpose applications console
MSFC	Marshall Space Flight Center
MSIS	Manned Systems Integration Standards
MSS	manned space station
N2	nitrogen
NASA	National Aeronautics & Space Administration
NC	noise criterion curve
NHB	NASA handbook
NOS	Network Operating System
NSTS	national space transportation system (shuttle)
OBL	octave band level
ODD/LDD	observed daily duration noise/limited daily duration noise
ODDNet	optical data distribution network
ORU	orbital replacement unit
PI	principal investigator
RF	radio frequency
RFP	Request for Proposal (9-BF-10-4-01P, Space Station Definition and Preliminary Design, 15 Sept 84)
SDP	subsystem data processor
SIL	speech interference level
SMS	space motion sickness
SOMS-A	shuttle on-board medical system, A modification
SSP	Space Station Program
SSPE's	Space Station program elements
STS	Space Transportation System
Specs	specifications
TBD	to be determined
TV	television
UV	ultra-violet
WMS	waste management system

1 INTERIOR ARCHITECTURE

101 GENERAL LAYOUT

10102 ACTIVITY VOLUME PER CREWMEMBER/FUNCTION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4 (2.2.1;2.2.10)

Revised: 9/23/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-02 The geometric arrangement of compartments shall provide necessary & adequate access, egress volumes, & envelopes to all functions within the station.	124(p 10-22)
-03 Hatches and doors internal to a single module shall be configured to minimize body reorientation on pass through.	124(p 10-23)
-04 Habitability manned system and subsystems hardware & software shall be designed to facilitate maintenance.	132(C-4, 2.01.09(3))
-05 <i>*(Private quarters for each crewmember shall be provided & shall each contain a minimum of 4.25 cubic meters(150 cubic feet) of volume.)*</i>	132(C-4,2.02 1.10.2(d)); 155
-07 Crew quarters shall be large enough for ease in donning & doffing clothing & rapid egress from a sleep restraint in an emergency.	132(C-4, 2.2.10.2(d))
-08 Sufficient volume for dining shall be initially allotted to feed the entire crew at each meal as a group.	124(p 10-23)
-09 Commode compartments shall be large enough to permit donning, doffing, & temporary storage of clothing. The hand washer shall be located in close proximity to the commode area.	132(C-4, 2.2.10.2i)
-10 Layout and volume provisions shall accommodate entire crew on a common work shift.	132(C-3-6, 2.2.c; C-3-9,8)
-11 The geometric arrangement of compartments and passage clearances shall allow adequate access for an EMU-suited crewmember during contingency operations for regaining a safe IVA environment, e.g., module removal & relocation for leak repair; repair of ECLS system.	131 Crit. Assmpt 6.7,9

CANDIDATE SOLUTIONSREFER. NO.

None

|
|CRITICAL ASSUMPTIONSREFER. NO.

- o All activity areas will be sized and configured to anthropometric specifications as defined in the NASA Request for Proposal, September 1984.
- o Crew of 6 at IOC, manned.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

1 INTERIOR ARCHITECTURE

101 GENERAL LAYOUT

10104 DEDICATED VS MULTIPURPOSE SPACE UTILIZATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 11/4/85

REQUIREMENTS

REFER. NO.

- | | |
|---|----------------------|
| -01 Workstations shall be located throughout the Space Station in all the habitable modules. They shall be capable of supporting Space Station operations, customer services, crew health & equipment maintenance. Crew stations with multiple uses shall be developed. | 135(p 91) |
| -02 The wardroom/dining area shall accommodate the entire crew simultaneously & serve as a meeting and dining area, lounge, viewing & recreational area. | 132 (C-4, 2.2.10.2f) |
| -03 The wardroom shall not be used as a major work or writing station. | 131 |
| -04 The exercise area and equipment shall be designed for physical conditioning as well as recreation. | 133(p 3-29) |
| -05 <i>*(Multiple use of volume shall be made where practical.)*</i> | 132 |

CANDIDATE SOLUTIONS

REFER. NO.

None

|

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

101 GENERAL LAYOUT

10106 EQUIPMENT & FURNISHING REQUIREMENTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 11/4/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Furnishings must meet the requirements of 0-g posture as in NASA Reference Publication 1024 or later issues.	132
-02 Live network color TV & CCTV shall be available for crew entertainment and/or training.	132(C-4, 2.2.6.2b)
-03 Drawers & cabinets shall be equipped with suitable restraints to allow access, removal & restowage of equipment.	132(C-4, 2.2.10.1f)
-04 Stowage devices and areas shall be equipped with means to prevent small items from drifting.	132(C-4, 2.2.10.1f)
-05 Cleaning equipment and supplies shall be provided by the Space Station for use by the crewmembers.	132(C-4, 2.2.10.1h)
-06 Methods for controlling lights (on, off and variable intensity) shall be provided at entrances and exits of habitable areas.	132(C-4, 2.2.10.1c)
-07 Night light route locators & switch illumination shall be placed in areas that are frequently darkened in the Space Station.	132(C-4, 2.2.10.1c)
-08 Provisions, e.g. electrical outlets, shall be available for onboard maintenance, to be accomplished at potential problem locations or at some designated maintenance location.	132(C-4, 2.2.10.2c)
-09 Independent lighting, ventilation and temperature control shall be provided in crew quarters & shall be adjustable from a sleep restraint.	132(C-4, 2.2.10.2d)
-10 As a minimum, audio/video entertainment, bulletin board, reading/writing provisions, & mirrors shall be provided in crew quarters.	132(C-4, 2.2.10.2d)

- | | |
|---|---|
| -11 Crew quarters shall be acoustically isolated, provide caution/warning alarms, storage of personal items, desk facilities, and a method of securing clothes, & books. | 132(C-4,
2.2.10.2d) |
| -12 The wardroom/dining area shall be provided with audio/video entertainment equipment, game kits, windows & IVA communications. | 132(C-4,
2.2.10.1f) |
| -13 Personal hygiene areas include facilities for body waste collection, personal cleanliness, bathing and appropriate interfaces with the ECLSS. | 132(C-4,
2.2.10.2i) |
| -14 Full body shower facilities shall be provided for use in case of chemical burns proximal to and within the module where hazardous chemical handling areas exist. | 132(C-4,
2.2.10.2i) |
| -15 The showers in the personal hygiene areas shall have mixed hot and cold water controls, permit hair & scalp washing, and provide a temperature controlled (heated) private dressing area. | 132(C-4,
2.2.10.2i) |
| -16 Laundry facilities shall be provided to clean & dry extravehicular inner cooling garments, & crew IVA clothing and linens.. | 132(C-4,
2.2.10.2k) |
| -17 Windows shall be provided for the purposes of EVA monitoring, proximity operations, manipulator operations, customer operations, photographic tasks, and recreation. | 132(C-4,
3.2m) |
| -18 Capability shall be provided for detecting & extinguishing any fire in Space Station habitable volumes. | 132(C-4,
2.1.11.2i) |
| -19 Personal hygiene equipment to support shaving, face & hand washing, and oral hygiene shall be individual and near the crew quarters. | 132(C-4,
2.2.10.2d) |
| -20 Clocks indicating day of the week, date and time shall be placed strategically throughout the station. | 124(p 10-24) |
| -21 Controls for regaining a safe environment shall be accessible and designed for EMU-gloved hands. | 132(C-4.2.2.
10.2c)
Crit. Assump
6,7,9 |
| -22 Crew quarters and personal hygiene areas shall be located in proximity to each other. | 132(C-3-11,
2.5-a) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

- 1 INTERIOR ARCHITECTURE
- 101 GENERAL LAYOUT
- 10107 PHYSICAL/FUNCTIONAL ADJACENCIES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 11/4/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 <i>*(Functional group interrelationships of compartments shall be a prime consideration in the basic manned habitat layout arrangement.)*</i>	132(C-4, 2.2.10.01)
-02 Separation of work, sleep, exercise & eating areas shall be provided.	128
-03 Clear zone translation traffic routes shall not interfere with the working, eating, sleeping or relaxation of crewmembers.	132(C-4, 2.2.10.1g)
-04 Sleeping/private areas shall be separate from noise generators.	103(p 2.1.1)
-05 Entry & exit from private quarters shall not disturb others.	128
-06 Absolute privacy during bathing & other personal hygiene activities shall be available.	135 (p 16)
-07 The commodes shall be located away from the food preparation and dining area & near private crew quarters.	132(C-4, 2.2.10.2i)
-08 A handwasher shall be included inside and/or near the commode area.	132(C-4, 2.2.10.2i)
-09 Handwashing facilities & potable water dispenser shall be in close proximity to the HMF.	132(C-4, 2.2.10.2g)
-10 The galley shall be separated from private crew quarters.	132(C-4, 2.2.10.2e)
-11 The galley shall be separated from personal hygiene areas.	132(C-4, 2.2.10.2e)
-12 The habitat shall be arranged and designed to facilitate the stabilization & storage of trash. The equipment necessary for trash storage & stabilization shall be conveniently located for collection & use by all crew-	124(p 10-24)

members.

- | | |
|---|------------------------|
| -13 A handwasher shall be in close proximity to the galley. | 132(C-4,
2.2.10.2e) |
| -14 A maintenance work area shall be provided which is capable of being isolated from the remainder of the vehicle. Curtains, airflow or other suitable methods may be used to contain the contaminants which result from the maintenance activities. | 124(C-I-15) |
| -15 Separation of flammable materials from potential ignition sources in a module is required to the maximum extent possible. | 132(C-4,
2.1.11.3c) |
| -16 The capability to seal hazardous operations from other areas shall be provided for the duration of the operation. | 132(C-3-6,
2.2) |
| -17 Emergency life support, damage assessment, & medical equipment shall be readily accessible to the crew. | 132(C-4,
2.1.11.2n) |
| -18 Redundant accommodations for complete command & control of the Space Station shall be provided in separate pressurized volumes. | 132(C-4,
2.1.11.4b) |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

101 GENERAL LAYOUT

10108 INTER/INTRA-MODULE EQUIPMENT ORIENTATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 9/23/85REQUIREMENTSREFER. NO.

-01 **(A consistent visual reference shall be used to minimize the potential for crewmember disorientation.)**

1132(C-4,
2.2.1.2b)

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
101 GENERAL LAYOUT
10109 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 11/4/85

REQUIREMENTS

REFER. NO.

- | | |
|---|--|
| -01 Volume, space, compartmentalization & arrangement shall retain at least the same minimum criteria for growth as for manned IOC. This shall include needed clearances for contingency EMU suited operations. | 130(p 4-24)
 132
 Crit Assumpt
 6,7,9 |
| -02 The habitable volumes, crew facilities and equipment shall be designed to facilitate system growth, on-orbit reconfiguration and update through use of modular design. | 132(C-4,
 2.1.5;
 2.2.10.1) |
| -04 The Space Station shall have a workbench/workshop equipped with standard tools & diagnostic aids, coupled with maintenance procedures. As the station grows, the capability of this work area should grow. | 124 |
| -05 The habitability areas shall be modular in design to facilitate growth & changes in component elements as mission complexity increases. | 132(C-4,
 2.2.10.2g) |
| -06 The habitable module shall be designed to accommodate the incorporation of new technology as appropriate to optimize benefits to the program. | 132(C-4,
 2.1.6) |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

102 TRAFFIC FLOW

10201 FREQUENCY OF TRANSIT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 9/23/85REQUIREMENTSREFER. NO.

- | | |
|--|------------------------------------|
| -01 <i>*(Traffic routes shall be designed to consider frequency of use and the best combinations of uses of the volumes considered for the specific traffic route.)*</i> | 132(C-4,
 2.2.10.1,
 (g)01b) |
| -02 Flow patterns shall minimize the distance large masses are transported and reduce as much as possible the congestion caused by large masses transported through tight areas. | 135(p 12,
 2.1.2) |
| -03 Habitability accommodations & facilities shall be designed to the O-g neutral body posture, traffic patterns, congestion avoidance, cleaning and ease of maintenance. | 132(C-4,
 2.2.10.1) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

- 1 INTERIOR ARCHITECTURE
- 102 TRAFFIC FLOW
- 10202 EQUIPMENT ACCOMMODATIONS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

- 01 **(A functional capability shall be provided to bring internally or externally located ORU's into the pressurized work area to conduct maintenance.)** 132(C-3, 03.02(e))
- 02 Berthing ports & hatches shall be sized & shaped by EVA requirements, package dimensions, and hatch thruway limitations & shall be no less than 1.27 m (50 inches) internal diameter. 132(C-4, 2.2.2.2b)
- 04 Equipment located near traffic routes & work-station areas shall be designed to accommodate crew movement. 132(C-4, 2.2.10.1g)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

- 1 INTERIOR ARCHITECTURE
- 102 TRAFFIC FLOW
- 10203 CONGESTION MINIMIZATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

- 02 Alternate paths of traffic flow shall be considered to avoid general congestion, sensitive experimental areas, and sleep areas. | 135(p 13)
- 03 Translation traffic routes shall not interfere with the working, eating, sleeping, or relaxation of crewmembers. | 132(C-4,
2.2.10.1g)
131
- 04 The minimizing of travel time & effort and the provision of safe, controlled translation shall be considered. | 132(C-4,
2.2.10.1g)
- 05 Scheduling shall be considered to avoid traffic flow congestion. | 135(p 23)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

- * An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

102 TRAFFIC FLOW

10204 PASSAGE IMPINGEMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 9/23/85REQUIREMENTSREFER. NO.

- | | |
|---|--|
| -01 Hatches & doors, internal to a single module, shall be configured to minimize body reorientation on pass through. | 124(p 3-26),
3.1.12.3 |
| -02 Hatches, interconnecting tunnels, passageways, etc., shall be no less than 1.27 m. (50 in) internal diameter. | 132(C-4,
2.2.10.1g) |
| -03 A clear zone shall be established contiguous with each hatch & bulkhead opening, requiring all surfaces be free of hardware protrusions, sharp corners and edges, & recesses or holes. | 132(C-4,
2.2.10.1g) |
| -04 A means shall be provided for avoiding bruises & abrasions from inadvertent contact with protrusions, especially around doorways, where changes of direction are made during translation; and along traffic pathways. | 131 |
| -05 When not in use, workstation restraint systems shall leave the aisle clear and with no surfaces protruding. | 132(C-4,
2.2.10.1g) |
| -06 Hoses & cables shall be restrained and out of the way of traffic paths. | 138
(p 34) |
| -08 All passages shall provide clearance for contingency EMU-suited operations. | 132(C-4,2.2.10) Crit
Assump 6,7,
9 |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
102 TRAFFIC FLOW
10205 EMERGENCY EGRESS/INGRESS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)
C-3(2.2.b)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

- | | |
|---|------------------------|
| -01 The arrangement of any habitable compartment shall take into account the possibility of a subsystem failure or damage that could require safe evacuation. | 103 |
| -02 Crewmembers shall be able to egress or isolate themselves in any habitable area when a hazardous condition occurs. | 132(C-3,
2.2.b) |
| -03 Crew quarters shall be large enough for ease of rapid egress from a sleep restraint in an emergency. | 132(C-4,
2.2.10.2d) |
| -04 Traffic regulations & flow routes for contingency situations shall be established for safe & efficient movement of personnel and equipment. | 137(p 2-1,
2.1) |
| -05 Where practical provide dual escape routes from all activity areas to serve in the event that one route is impassable. | 139(p 22) |

CANDIDATE SOLUTIONS

REFER. NO.

None

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CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

102 TRAFFIC FLOW

10206 CREW/EQUIPMENT TRANSLATION & HANDLING AIDS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 10/21/85

REQUIREMENTS

REFER. NO.

- | | |
|--|--|
| -01 Hardware shall be designed to withstand in-advertent collision, and for use as a mobility aid or temporary restraint. | 131 |
| -02 Crew & equipment restraints & locomotion aids shall be provided in every module. | 132 (C-4,
 2.2.10.1g)
 137(2.1,
 p 2-1) |
| -03 The station shall be provided with visual markings & other cues to provide the crew directional & spatial orientation for use with mobility & restraint devices for both IVA and EMU-suited crewmembers. | 137(2.1,
 p 2-1)
 Crit
 Assumpt
 6,7,9 |
| -04 Provide a means of preventing inadvertent operation of switches & circuit breakers. | 131 |
| -05 Provide sufficient volume around the hatch operational envelope to prevent unusual body contortions. | 133(p 109,
 4.3.2.3.2) |
| -06 The design of the restraint system interface with the station structure shall be common for all modules. | 132(C-4,
 2.2.10.1g) |
| -07 Equipment restraints shall be provided to anchor every item of use that is not permanently attached to the station. | 132(C-4,
 2.2.10.1g) |
| -08 Handholds/handrails shall be strategically located to assist entry/exit at workstations as needed. | 132(C-4,
 2.2.10.1g) |
| -09 Appropriate body & equipment restraints shall be placed in each personal hygiene area. | 132(C-4,
 2.2.10.2i) |
| -10 Crew & equipment restraints and handhold provisions shall be made for contingency EMU-suited operations. | Crit Assumpt
 6,7,9 |

CANDIDATE SOLUTIONS

None

REFER. NO.

!

CRITICAL ASSUMPTIONS

None

REFER. NO.

- * An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
103 DECOR
10301 COLOR, TEXTURE, GRAPHICS & LIGHTING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

-01 <i>*(Interior design guidelines for color and lighting shall be applied per MSIS.)*</i>	130(p 205, 3.5.4)
-02 Colors, lighting & textures shall be used to provide: visual orientation cues (e.g., local vertical & emergency exit cues), equipment stowage location cues, location aids, aesthetic variety, & contrast for the crews.	132(C-4, 2.2.10.1) 141
-03 Labeling and markings shall be per the MSIS.	141

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

o International crew will be immediately familiar with English labels/markings, so that special symbol enhancement is not needed.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
103 DECOR
10302 INTERIOR DESIGN MODIFIABILITY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

-01 **(Interior design features shall be provided to allow variations in color, decor, lighting, graphics, textures, etc. to maintain a varied and stimulating living-working environment.)** | 130,131,124
| 140,138
-02 The capability for personalization of private crew quarters shall be provided. | 132(2.2.10
| .2);369

CANDIDATE SOLUTIONS

REFER. NO.

GEN Provide changeable color panels.
GEN Integrate lighting colors and surface colors to achieve fixed and variable effects.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

103 DECOR

10303 CODING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

- | | |
|---|----------------------------|
| -01 The Space Station interior shall be provided with visual markings & other cues to provide the crew directional & spatial orientation for use with mobility & restraint devices. | 137(p 2-1, 2.1) |
| -02 Color and/or graphics shall be utilized as aids in crew location of stowage items. | 131(C-4, 2.2.10.01, (f)01) |
| -03 Provisions shall be made so that the crew can quickly find critical valves, switches, etc., in emergencies. | 124 (p 10-23(K)) |
| -04 <i>*(Space Station personnel shall be able to specify location points within & without the Space Station.)*</i> | 131,132 (1.1.4) |
| -06 Markings & labels shall be standardized throughout all Space Station modules. | 132(C-4, 2.2.10.1a) |
| -08 Stowage provisions & restraints shall allow for easy identification of contents without removal of items. | 132(C-4, 2.2.10.1f) |
| -09 Where possible, labels & identifying codes on all packages, containers and equipment surfaces shall be changeable on-orbit & remain clearly visible & unobstructed to crewmembers. | 124(p 10-23) 138 |
| -10 <i>*(Integrated coding criteria for color, graphic, texture, and labeling shall be applied within the Space Station to avoid overuse, ambiguities, visual clutter and information overload.)*</i> | 140,138,137 |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- o International crewmembers will be immediately familiar with English labels/markings so that special symbol enhancement is not needed.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

DESIGN/OPERATIONS REQUIREMENTS

104 MATERIALS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10)

Revised: 9/23/85

REFER. NO.

-01 *(Materials shall be selected for esthetic and functional acceptability & suitability, extended life, technological maturity, manufacturability, inspectability, contamination characteristics, specific strength, compatibility, availability, cost & safety.)*

REFER. NO.

None

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

104 MATERIALS

10401 HEALTH AND SAFETY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1;2.2.10;2.1.11)

Revised: 9/23/85REQUIREMENTSREFER. NO.

- | | |
|---|-----------------------|
| -01 Interior areas of the Space Station shall be devoid of sharp-edged surfaces. | 132(C-4,2.2.10.1);149 |
| -02 A means of avoiding bruises & abrasions from inadvertent contact with protrusions shall be provided. | 131 |
| -03 In the event of fire, the interior walls and secondary structures within the Space Station shall be self-extinguishing. | 132(C-4,2.1.11.2) |
| -04 Materials & components subject to insidious degradation in the Space Station ionizing environment shall not be used where that degradation can cause or contribute to any crew hazards. | 132(C-4,2.1.11.3a) |
| -05 Separation of flammable materials from potential ignition sources in a module shall be required to the maximum extent possible. | 132(C-4,2.1.11.3d) |
| -06 The use of hazardous materials shall be minimized; those used shall meet the applicable requirements specified in NHB 8060.1B, "Flammability, Odor & Offgassing Requirements & Test Procedures for Materials Used in Environments that Support Combustion", (J8400003). | 132(C-4,2.1.11.3a) |

CANDIDATE SOLUTIONSREFER. NO.

None

|

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
104 MATERIALS
10402 MAINTENANCE AND REPAIR

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.11;2.2.10)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-------------------------|
| -01 All areas of the Space Station shall be conveniently cleanable & maintainable. | 132(C-4,
 2.2.10.1h) |
| -02 All Space Station walls, bulkheads, hatches & seals where integrity is required to maintain pressurization shall be accessible for inspection, maintenance, or repair by shirt-sleeve crewmembers. | 132(C-4,
 2.1.11.2d) |
| -03 <i>*(Internal access to walls shall be provided for detection, isolation, & repair of pressure shell leaks by EMU-suited personnel.)*</i> | 133(p 37) |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

104 MATERIALS

10403 DURABILITY & SUSCEPTABILITY TO DAMAGE

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1.3)

Revised: 9/23/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Interior materials & finishes that are susceptible to abrasion on the ground during prelaunch preparations & in flight shall be selected to ensure durability.	142 (4.1.5.2)
-02 Consideration shall be given in material selection to providing adequate strength at minimum weight.	142 (4.1.5.2)
-03 Materials selected shall be resistant to spilled chemicals, grease, body excretions, fungi, moisture, direct sunlight, ozone, particles in the air, and any other corrosive contaminants.	142 (4.1.5.2)
-04 Systems, subsystems, or equipment located in pressurized volumes designed to withstand decompression & repressurization shall be capable of tolerating the differential pressure and depressurized condition without resulting in a hazard.	132(C-4, 2.1.11.2d)
-05 All transparent surfaces, e.g., displays, windows, etc. shall be scratch/mar resistant where possible and protected from releasing broken particles.	142 (4.1.5.2)

<u>CANDIDATE SOLUTIONS</u>	<u>REFER. NO.</u>
None	

<u>CRITICAL ASSUMPTIONS</u>	<u>REFER. NO.</u>
None	

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

104 MATERIALS

10404 AUDITORY, OLFACTORY & TACTILE EFFECTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10;2.1.11)

Revised: 9/30/85

REQUIREMENTS

REFER. NO.

- | | |
|---|----------------------|
| -01 Materials shall be selected to provide sufficient sound control and to help to reduce all unwanted noises to the minimum level reasonably achievable and in accordance with specifications. (See 20501) Special considerations shall be given to the noise levels in the sleeping quarters. | 124(p 10-22) |
| -02 Crew quarters shall be acoustically isolated. | 132(C-4, 2.2.10.2d) |
| -03 Materials used in Space Station habitable volumes shall meet the requirements of NHB 8060.1B, (J8400003) for toxic outgas constituents in the lowest operating pressure to which they may be exposed. | 132(C-4, 2.1.11.3.d) |
| -04 Exposed surfaces within habitable Space Station modules shall not exceed a temperature of 113 degrees F (45 degrees C). | 132(C-4, 2.1.11.2h) |
| -05 Exposed surfaces within habitable Space Station modules shall not be below a temperature of 40 degrees F (4 degrees C). | 132(C-4, 2.1.11.2h) |
| -06 Textural variation shall be utilized in the interior design to enhance habitability/variation for crewmembers. | 131 |
| -07 Infrared (IR) reflective materials & surfaces shall be used where possible. | 155 |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

1 INTERIOR ARCHITECTURE
104 MATERIALS
10405 ELECTROMAGNETIC PROPERTIES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.11;2.1.3)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-------------------|
| -01 Operations & systems design shall provide protection from externally & internally produced radiation/EMI. | 124(p 10-12) |
| -02 The habitable modules shall be designed to meet all applicable performance requirements while operating in the induced electromagnetic environments of the checkout, launch and orbital locations. | 132(C-4, 2.1.3.2) |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
105 ANTHROPOMETRY
10501 POPULATION CHARACTERISTICS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

-01 *(The design of crew subsystems shall accom-	132(C-4,
modate the 5th-percentile Oriental female to	2.2.10.01(b)
95th-percentile American male anthropometric	132(C-4-47)
range.)*	

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
105 ANTHROPOMETRY
10502 RANGE OF ACCOMMODATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

- 01 **(The design of crew subsystems shall use the [TBD] anthropometric strength levels adjusted for 30-year growth trends from the baseline estimate year 1985, extrapolated to the year 2000.)** | 132(C-4,
| 2.2.10.1,
| (b))
-04 Where design cannot reasonably accommodate the | 132(C-4,
| desired anthropometric range, recommendations | 2.2.10.1b)
| shall be made to utilize alternative
| solutions.

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

105 ANTHROPOMETRY

10503 PHYSICAL DIMENSIONS & LIMITS IN MICRO-G

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10;2.1.11)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

-01 Accommodations, workstations, furnishings, passageway locomotion aids, and facilities shall be designed to the 0-g neutral body posture.	132(C-4, 2.2.10.01) 124(C-4, 2.2.10.1g) 131,152
-03 <i>*(Accommodations and facilities shall be compatible with anthropomorphic changes that occur in space.)*</i>	138,152

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

106 MODULARITY

10601 GENERAL

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1.2;2.1.5;2.2.10.1)

Revised: 9/23/85REQUIREMENTSREFER. NO.

- | | |
|---|--|
| -01 <i>*(Crewmembers shall be able to reconfigure interior volume arrangements to accommodate revised configurations.)*</i> | 131(1.1.3)
 145(p 2-5)
 132(C-4-23,
 2.2.1.2) |
| -02 <i>*(Interfaces between primary and secondary structure and between subsystems and their attachment to structure shall be standardized to minimize human involvement in inflight repair, maintenance and reconfiguration.)*</i> | 132(2.2.1.2) |
| -03 Habitability design shall facilitate system growth through use of modular and subsystem design. | 132(C-4,
 2.1.5) |
| -04 Health Maintenance Facility shall be modular in design to facilitate growth and changes in component elements as mission complexity increases. | 132(C-4,
 2.2.10.1f) |
| -05 Modular stowage lockers shall be incorporated into the overall interior arrangement of the station. | 132(C-4,
 2.2.10.1f)
 124(p 3-5) |
| -06 System design shall provide interfaces that prevent mislocation of equipment modules or intermixing of equipment interface connectors. | 136 |
| -07 Removal & temporary relocation of partitions/modules which must be moved for wall access (as for leak repair) shall be designed for EMU-suit gloved hand operation. | Crit Assumpt
 6,7,9
 131(1.1.3) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

1 INTERIOR ARCHITECTURE

106 MODULARITY

10603 EXISTING STANDARDS AND CONVENTIONS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.5;2.2.10.1)

Revised: 9/23/85REQUIREMENTSREFER. NO.

- 01 **(Design equipment racks per TBD criteria to provide flexibility in various module configurations.)** | 145(p 2-5)
|
-02 Equipment racks shall accommodate a standard | 143(p 7-3,
19 inch (single) and 38 inch (double) width | pp. 7.1.3.2)
(48.26 cm and 96.52 cm). | 144(p 3-84,
| pp. 3.4.1.
| 1.1), 145
|
-03 **(Provide standardized utility interfaces in modular design.)** | 144(p 3-84,
| 85, pp.
| 3.4.1.2, 3.4.
| 1.3, 3.4.1
| 1.4), 145

CANDIDATE SOLUTIONSREFER. NO.None
|
|CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
106 MODULARITY
10605 MAINTAINABILITY SUPPORT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1)

Revised: 9/23/85

REQUIREMENTS

REFER. NO.

- 01 Functionally independent subsystems shall be developed, as appropriate, in order to facilitate maintenance and operations. 132(C-3.13-13.2 pp. j)
- 02 Mechanisms shall be designed as independent assemblies with distinct and definable interfaces. Mechanisms shall be designed, where practical, to be removed and replaced on-orbit. 132(2.2.2.1)
- 03 Personal and equipment mobility aids and restraints shall be provided to support on-orbit maintenance. 132(C-4-49) 132(2.2.10.1g)
- 04 **(The hardware shall be designed or integrated to use common fasteners, connections, tools, and packaging.)** 146
- 05 The orbital replaceable hardware (ORU's) shall be designed for ease of on-orbit replacement. All connections shall be designed and labeled to preclude improper mating. 126
- 06 Where feasible, ORU;s shall be standardized. 126

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

106 MODULARITY

10607 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.5)

Revised: 9/23/85REQUIREMENTSREFER. NO.

- | | |
|--|------------|
| -02 The SSP and its systems and subsystems shall have the capability to be progressively modified or upgraded on-orbit to accommodate evolving technologies to optimize use of equipment and facilities by the crew. | 132(2.1) |
| -03 <i>*(The SSPE's shall be designed to facilitate system growth and reconfiguration through use of modular and subsystem design. The SSPE's shall employ common hardware, software, and standard interfaces which optimize crew utilization and reconfiguration of equipment and subsystems.)*</i> | 132(2.1.5) |
| -04 To the maximum extent practical, modification of the SSP or its subsystems shall maintain hardware and software service commonality for customer applications so that productivity will not be adversely affected by unfamiliar systems. | 132(2.1) |

CANDIDATE SOLUTIONSREFER. NO.

GEN Modular system and subsystem design will satisfy the requirement by providing capability to be modified or upgraded and by providing systems commonality.	
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CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

107 WINDOW/REMOTE VIEWING

10701 VIEWING REQUIREMENTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-1(2.2.3.2);C-2(3.1.1)
C-1(4.2.1.2);C-4(2.2.10.1.d)

Revised: 9/24/85REQUIREMENTSREFER. NO.

(NOTE: Refer to 40103-01 for Window Workstation Requirements)

- | | |
|--|-----------------------------------|
| -01 Provide a means of achieving the greatest possible reduction in reflectance on all surfaces of all window panels. | 148,167 |
| -02 The window characteristics shall be compatible with thru-window photographic requirements. | 148,167 |
| -03 Observation windows shall have a minimum diameter of 20" to provide binocular viewing through a window simultaneously by two 95th percentile male crewmembers. | 159,131 |
| -04 a. Provide a means to control and prevent the transmission of ultraviolet, visible, infrared, microwave and ionizing radiation. | 166,151
132(2.2.10.
J.3(b)) |
| b. Coordinate window shielding design with other radiation protection work to achieve less than allowable dose levels. (20302) | |
| c. Internal EM environment to be within ACGIH, ANSI guidelines, coordinate with laser systems design. (20304) | |

CANDIDATE SOLUTIONSREFER. NO.

GEN Use window filters

GEN Use opaque shades

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

- 1 INTERIOR ARCHITECTURE
- 107 WINDOW/REMOTE VIEWING
- 10702 WINDOW OPTICAL CHARACTERISTICS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.d)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

- 01 Haze - The haze value for the window assembly shall be less than 2.5% at the installed angle | 153
- 02 Light Transmission |
 - a. The transmission of the window assembly shall not be less than 65% of the visible spectrum at the installed angle. | 151
 - b. Ultraviolet, infrared, microwave, and ionizing radiation shall be controlled to less than allowable limits. |
- 03 Surface Distortion | 352
 - a. Wavefront deformation shall not exceed 200 nanometers, peak to peak, over any 4" diameter area across the surface of the window, for all angles up to 45 degrees from normal. |
 - b. Parallelism shall not be exceeded by more than 2 arc seconds between the two surfaces of one panel; and shall not exceed 30 arc seconds between panels. |
 - c. Surface scratch and dig shall be 60/40 per MIL-0-13830B or better. |

CANDIDATE SOLUTIONS

REFER. NO.

None |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
107 WINDOW/REMOTE VIEWING
10703 WINDOW CONFIGURATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(3.2m);C-4(2.2.10)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

(NOTE: Refer to 40103-01 for Window Workstation Requirements)	
-03 The window assembly shall consist of at least two panels.	148,150, 154
-04 Provide de-ice and defog capabilities.	148,150 131(p 1.1.1)
-05 Windows shall be designed to minimize the probability of having to depressurize modules in order to replace panels.	132(C-4-23) 352
-06 Windows shall be impact resistant and have multiple panels to protect against micrometeorite or debris impact, and overpressure failure.	132(C-4-23) 352

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

107 WINDOW/REMOTE VIEWING

10704 WINDOW ACCESS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1d)

Revised: 9/24/85

REQUIREMENTSREFER. NO.

(NOTE: Refer to 40103-01 for Window Workstation Requirements).

-01 The architectural arrangement of equipment near the windows shall allow adequate space for the performance of operational, maintenance, and recreational tasks by two 95th percentile American male crewmembers.	131,132 (C-4 2.2.10.1d)
--	--

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
107 WINDOW/REMOTE VIEWING
10705 WINDOW LOCATION AND NUMBER

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1d)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

(NOTE: Refer to 40103-01 for Window Workstation Requirements)

- | | |
|---|---------|
| -01 Provide at least one window in each main habitable area which, when used with other windows, will allow viewing in all directions from the Space Station. | 131,158 |
| -02 Provide workstation windows in accordance with operational viewing requirements (Refer to 40103). | 131 |
| -03 Provide a window in each airlock and hatch door allowing a 45 degree field of view in all directions from nadir. | 147 |

CANDIDATE SOLUTIONS

REFER. NO.

GEN Provide a viewing window with a 45 degree field of view in all directions from nadir for each private quarter assuming a minimum viewing distance but not less than 10 inch (25.4 cm) diameter.	131
---	-----

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
107 WINDOW/REMOTE VIEWING
10706 WINDOW MAINTENANCE/PROTECTION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1d)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

-01 *(Provide cleaning equipment and materials which are compatible with the window surfaces.)*	131
-02 *(Provide easily installed and removable inner and outer window protective covers per TBD criteria in addition to radiation attenuators. The outer window cover shall be controlled remotely from within the interior.)*	131,154,151 352

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE
107 WINDOW/REMOTE VIEWING
10707 INDIRECT VIEWING OPTIONS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11.2a)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

-01 Provide optical viewing devices and/or closed circuit television where external visual monitoring tasks cannot be performed by direct vision. (Direct vision is preferred).

1156,157
|
|
|

CANDIDATE SOLUTIONS

REFER. NO.

None

|

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

1 INTERIOR ARCHITECTURE

109 STOWAGE/STORAGE

10901 CREW EQUIPMENT STOWAGE

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1f)

Revised: 10/21/85

REQUIREMENTS

REFER. NO.

- | | |
|---|--------------------------|
| -01 *(TBD cubic meters (feet) of stowage volume shall be provided in the crew quarters for stowing clothing.)* | 133(p 97) |
| -02 *(TBD cubic meters (feet) of stowage volume shall be provided for workstation/ancillary provisions such as writing equipment, film, camera equipment, etc.)* | 133(p 97) |
| -03 *(TBD cubic meters (feet) of stowage volume shall be provided for personal hygiene equipment, including:
Tissue Dispenser
Personal Wetwipes
Towels
Washcloths)* | 133(p 97) |
| -04 *(TBD cubic meters (feet) of stowage volume shall be provided for logistical supplies, including:
Clothing (14 Days)
Food (90 Days)
Bedding (90 Days)
Additional Stowage)* | 133(p 97) |
| -05 *(TBD cubic meters (feet) of stowage volume shall be provided for additional supplies/equipment, including:
Equipment Containers/Restraints
Maintenance Workstation
Wardroom
Additional HAB 1
Additional HAB 2
Additional LAB 1
Additional LAB 2)* | 133(p 97) |
| -06 A place to store personal items shall be provided. | 128(p 36)
103(p 2-12) |
| -07 A place to store small items overnight shall be provided. | 128(p 36)
103(p 2-12) |

- 08 A place to stow and dry clothes overnight shall be provided. 128(p 36)
103(p 2-12)
- 09 **(Stowage shall be provided in the galley based on:*
 Refrigerator (14 Days)
 Freezer (14 Days)
 Ambient Food (14 Days)
 Utensil/Appliance Stowage
 Trash Stowage
 *Housekeeping Supplies)** 133(p 97)
- 12 Stowage, retrieval, and restowing of all required crew support items shall be major factors in the interior arrangement of the station. 132(C-4-49)
- 13 The various stowage items shall be located as close to their use locations as is practical. 132(C-4-49)
103(p 2-12)
- 14 Modular stowage lockers shall be incorporated into the overall interior arrangements of the stations. 132(C-4-49)
103(p 2-14)
- 15 Common design latching devices shall be utilized for all stowage areas. 132(C-4-49)
103(p 2-14)
- 16 Stowage containers shall be equipped with suitable restraints to allow access, removal and restowage of equipment. 132(C-4-49)
103(p 2-14)
- 17 Stowage areas shall be compartmented in order to control equipment during stowage and removal of equipment. 132(C-4-49)
103(p 2-14)
- 18 The Space Station shall provide a general "stockroom" area to stow resupply items when stowing of the total mission requirements into the use location is not practical. This general "stockroom" area(s) shall be a clearly identifiable entity and shall encompass the following: 132(p 2-13)
 - Provisions to group like items together, e.g., all towels, all washcloths together
 - Provisions to access each group of like items dependent of the other groups.
 - Provisions to access individual items within each group independent of the other items in the group.
- 19 Dedicated use items, such as loose items required to perform specific experiment tasks shall be located adjacent to the experiment stowage location. 103(p 2-13)
- 21 Storage for emergency supplies of food, hygiene, clothes, etc., shall be such that a 28-day supply is available in the event that 132(C-4-18)

any module must be evacuated.

- | | |
|---|-------------|
| -22 A means shall be provided for segregating discrepant equipment pending disposition. | 155 |
| -23 Stowage containers and restraints shall be standardized when possible. | 128(p 2-14) |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|------------------------|
| 05 Controlled storage facilities should be provided for usable spares and test equipment. | |
| 16 To avoid "bottom of the drawer" syndrome, provide drawers and lockers in varying depths from shallow to deep, to permit grouping of similar sized items in a single layer in each drawer or locker. | |
| 14 Provide detachable containers with handles for contents that are to be transferred from one location to another as a group. | 131(p 67) |
| 14 Standard lockers and provisions should be used wherever possible. A standard hole pattern for attaching lockers on doors and walls should be provided. | 168(p 25)
100(p 50) |
| 14 Locker doors should have sufficient friction in the hinges to hold the doors in the open position to provide two-hand access to the inside of the lockers. | 168(p 25)
100(p 50) |
| 15 Provide simple latches which can be operated with one hand. | |

CRITICAL ASSUMPTIONS

REFER. NO.

- | | |
|---|-----------|
| o Stowage volumes allocated are derived from previous inflight experiences as well as extrapolation of consumables for six people over a 90-day period. | 133(p 91) |
| * <i>An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.</i> | |

- 1 INTERIOR ARCHITECTURE
- 109 STOWAGE/STORAGE
- 10902 FOOD/GALLEY STOWAGE EQUIPMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2e)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

- | | |
|---|------------------------|
| -01 <i>*(Food storage and stowage shall include provisions for frozen, perishable, and ambient stabilized food.)*</i> | 132(C-4-55) |
| -02 <i>*(Provisions shall include the capability for: Chilling to 35.6 degrees F (2 degrees C) and Storing between 35.6 degrees F and -9.4 degrees F (2 degrees C & -23 degrees C), and at Room temperature at 71.6 degrees F (22 degrees C).)*</i>
Storage compartments which contain frozen or perishable food shall provide high reliability thermal control systems. | 132(C-4-55)
155 |
| -04 Food storage areas and maneuvering shall be convenient and utilitarian. | 131(1.10.2) |
| -05 Resupply items shall be transported in bulk containers that can be transported intact. | 131(1.16.1) |
| -06 Bulk food storage shall be provided. | 132(C-4-55) |
| -07 All stowed food shall be easy to identify and secured to inhibit "floating". | 132(C-4-55) |
| -08 A pantry shall be provided such that all items of a kind can be kept together. | 131(p 85) |
| -09 Standard food storage contains shall be provided that fit both bulk stowage and pantry. | 131(p 85) |
| -10 Individual food stowage items shall be located conveniently near the crewman's place in the wardroom. | 168(p 25)
102(p 50) |
| -11 A separate chiller shall be provided for non-food items or use containers that ensure against contamination. | 131(p 85) |
| -12 Cooking/eating utensils shall be washed and reused, therefore, reducing the volume re- | 133(p 89) |

quired for stowage of these items.

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|---------------------------|
| <p>01 Food volume and weight
Approximate distribution to be as follows:
 Frozen Foods = 60%
 Ambient Foods = 30%
 Refrigerated Foods = 10%</p> <p>02 Freezer Design:
 Volume and location- 13.2 Cu. Ft. in Habitat #1.
 40 Cu. Ft. in logistics module
 Temperature- -10 degree F
 Cooling Sink- Water loop (45 degree F)
 Cooling Device- Thermoelectric
 Insulation- 2 inch (all outside surfaces)
 Power- 360 watts DC cyclic, 15 DC cont.
 Watts - Habitat #1
 815 Watts cyclic, 15 watts DC cont.
 - Logistics module
 Weight- 60 pounds in habitat #1
 180 Pounds in logistics module</p> | <p></p> <p>169(p 174)</p> |
|--|---------------------------|

CRITICAL ASSUMPTIONS

REFER. NO.

- | | |
|--|------------------|
| <p>o In addition to galley food stowage, the logistics module will provide food stowage locations.</p> <p>* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.</p> | <p>133(p 97)</p> |
|--|------------------|

- 1 INTERIOR ARCHITECTURE
- 109 STOWAGE/STORAGE
- 10903 TRASH-WASTE STOWAGE/STORAGE

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2e;2.2.10.1h)

Revised: 11/4/85

REQUIREMENTS

REFER. NO.

NOTE: For the purposes of this document, Waste is defined as bodily waste and Trash is defined as all other material to be disposed of.

(Also see 21302 - Trash Collection and 21307 - Trash Disposal)

- 01 **(TBD cubic meters (feet) of temporary "wet" and "dry" trash stowage volume shall be provided in the logistics module).** 133(p 97)
- 02 **(TBD cubic meters (feet) of temporary "wet" and "dry" trash stowage volume shall be provided in the galley).** 133(p 98)
132(2.2.10.2.e3)
- 03 **(A minimum of two wet and two dry trash stowage locations in each of the habitat and laboratory modules shall be provided).** 133(p 60)
- 04 Temporary trash stowage locations shall be provided at the points of greatest trash generation. 131(p 89)
128(p 62)
- 06 All biologically active trash shall be treated to prevent it from producing gas or odors during long term storage. 133(p 32)
132(C-4-50)
- 07 Biologically active trash shall be stowed separate from inactive dry trash prior to stabilization. 102(p 6)
171(p 2)
- 08 The habitat shall be arranged and designed to facilitate the management of trash/waste. The equipment necessary for trash/waste management shall be conveniently located for collection & use by all crewmembers. 126(p 32)
132(C-4-50)

CANDIDATE SOLUTIONSREFER. NO.

02 A means of identifying all potential stowage volume that becomes available for trash on a day-by-day basis should be devised. |171(p 12)
|
|

CRITICAL ASSUMPTIONSREFER. NO.

o Long term storage of trash/waste shall be centralized in the logistics module and returned to earth via the STS. 133(p 91)
172(p 28)

o Trash volume shall be compacted to a minimum of 4 to 1.

o Crew of six

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

1 INTERIOR ARCHITECTURE

109 STOWAGE/STORAGE

10904 DATA FILE STOWAGE

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1f)

Revised: 9/24/85REQUIREMENTSREFER. NO.

-01 <i>*(Data storage equipment (hard copy) shall be provided.)*</i>	169(p 54)
-02 <i>*(Digital storage equipment shall be provided.)*</i>	133(p 54)
-03 Crew data shall be output in the exact format to be used by the crew and should be compatible with the real-time uplink for presentation onboard.	169(p 54)
-04 Information shall be accessible with as many cross categories as required.	169(p 54)

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

- 1 INTERIOR ARCHITECTURE
- 109 STOWAGE/STORAGE
- 10905 STOWAGE VOLUME CONFIGURATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1f)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

- 01 **(Standard container sizes shall be provided.)** | 133(p 91)
- 02 Clearly visible, standardized color graphics & labeling shall be used as aids in identifying stowed items. | 132(C-4-49)
| 131(p 68)
- 04 **(Equipment stowage provisions & restraints shall allow for easy identification of the stowed item prior to removal.)** | 132(C-4-49)
| 103(p 2-14)
- 05 Stowage containers shall be equipped with means to prevent small items from drifting. | 132(C-4-49)
| 103(p 2-14)
- 06 Temporary restraint of equipment shall be provided near stowage areas, crew stations and throughout the Space Station. | 132(C-4-49)
| 131(p 67)

CANDIDATE SOLUTIONS

REFER. NO.

- 01 Provide three standard container sizes: 2, 5, and 20 cubic feet (0.06, 0.14 & 0.57 cubic meters). |
- 04 The use of transparent restraints is recommended so it is easy to identify items before trying to remove them. (Refer to 21503) | 128(p 54)
| 131(p 67)
- 05 Drawers should have internal restraints to prevent items drifting up behind drawers that are opened above, and then getting damaged or stuck. (Refer to 21503) | 128(p 54)

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

1 INTERIOR ARCHITECTURE

109 STOWAGE/STORAGE

10906 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1f)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

- | | |
|---|-------------|
| -02 Provisions shall be made for add-on (plug-in) stowage containers in existing modules. | 132(C-4-4a) |
| -03 The inventory mangement system shall be expandable to provide for additional stowage locations. | 132(C-4-4a) |
| | |
| | |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|---|--|
| GEN Off the shelf stowage equipment (e.g., refrigerator, freezer, food bins) should be selected from a product line that will enable upgrade to increase volume capacity with minimum changes required. | |
| | |
| | |

CRITICAL ASSUMPTIONS

REFER. NO.

- o Additional modules will provide storage volumes as required for increased crew sizes (life support items), spacecraft operational requirements, and additional experiments.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

201 INTERNAL ENVIRON

20101 ATMOSPHERE REVITALIZATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4 (2.2.9)

Revised: 9/30/85

REQUIREMENTSREFER. NO.

- | | |
|---|---|
| -01 A method of monitoring and regulating the partial and total pressure of gases in the module atmosphere shall be provided, and shall include a means of fire detection and suppression in each module. | 132
(C4,2.2.9.1) |
| -02 <i>*(Provide an internal environment adequate to support & maintain crew comfort, convenience, health, and well-being through all operational phases.)*</i> | 132 (Tables
C-4-IX.(a)
C-4-IX.(b))
173
(Appendix A) |
| -03 Crewmembers shall be able to modify temperature, humidity & ventilation rates within specified ranges inside the individual modules. | 132(C-4,
2.2.9.2b) |
| -04 Directable, adjustable air flow shall be available in each functional area. | 132(C-4,
2.2.10.2;
2.2.9) |
| -05 <i>*(The capability shall exist for dumping the atmosphere of a pressurized module overboard in the event of contamination or fire within that volume.)*</i> | 132 |
| -06 Monitoring and control of contaminants shall be provided. | 132(C-4,
2.2.9.1) |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|---|--|
| GEN Consideration should be given to comfort range relative to air temperature, ventilating rate and absolute humidity. | |
| GEN Auxilliary air flow shall be provided where required to maintain comfort. | |
| GEN Individual thermal and ventilation controls for sleep and waste management compartment are desirable. | |

CRITICAL ASSUMPTIONS

REFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

201 INTERNAL ENVIRON

20102 WATER MANAGEMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.9.2d)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

- | | |
|---|---|
| -01 The collection, processing, and dispensing of water to meet Space Station crew and experimental needs shall be accommodated. | 132
(C4, 2.2.9.1.d) |
| -02 <i>*(The ECLSS shall provide potable and hygiene water for distribution throughout the Space Station pressurized areas.)*</i> | 132(C4, 2.2.9.2d) |
| -03 A monitoring system to ensure proper water quality shall be provided to control and monitor contaminants (e.g., organic content, microbial growth and heavy metal ions) prior to water use. | 132(C-4, 2.2.9.1) |
| -04 <i>*(Water temperatures shall be controllable over the range 4 degrees to 82 degrees C (40 degrees to 180 degrees F.))*</i> | 103 |
| -05 <i>*(The amounts of water to be provided to the crew by the ECLSS for hygiene, potable & wash purposes are specified in Table C-4-IX(a) of reference 132.)*</i> | 132 (Table C-4-IX.(a)) |
| -06 <i>*(The quality of potable water to be provided, relative to chemical, physical and biological requirements, is defined in Figure C4-IX(a) and Fig. C4-IX(b) of reference 132.)*</i> | 173
(Appendix B)
132 (Table C-4-IX.(a)) |
| -07 Provide hot/cold potable water systems which avoid dispensing entrapped and dissolved gases. | 102(SLL #D-1) |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

201 INTERNAL ENVIRON

20103 CONTAMINATION/ODOR CONTROL

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1i,j)

Revised: 10/24/85REQUIREMENTSREFER. NO.

- | | |
|--|----------------------------|
| -02 *(Provide contaminant removal capability to maintain gaseous contaminants at or below spacecraft maximum [TBD] allowable concentrations.)* | 1132(C-4-51)
175(p D-1) |
| -03 Provide for gaseous contaminant monitoring to measure contaminant levels & to warn the crew if contaminants are approaching dangerous levels. | 132(C-4-51) |
| -04 Provide odor control and odor removal for body waste, and other odor producing elements. | 132(C-4-51) |
| -05 Provide air particulate load monitoring and control to maintain particulate levels to less than 353,000/m(3) for particles greater than 0.5 microns in size. | 132(C-4-51) |
| -07 Provide microbial contamination load monitoring and control in accordance with JSC-16888. | 132(C-4-51)
176 |
| -09 Provide capability for microbiological isolation between crewmembers and non-human biological specimens. | 132(C-4-51)
176 |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|---|-------------------------|
| GEN Provide a gaseous contaminant load model based on equipment, material & experiment offgassing crew & experiment metabolic loads & crew experiment & equipment operations. | 175(p 2.1)
178(p 19) |
| GEN Provide a central contaminant removal system as part of the common module ECLSS augmented in each lab by special removal capability tailored to each module needs. | 178(p 46) |
| GEN Provide a central generalized contaminant monitoring capability augmented by specialized instruments and ground based analysis. | |

GEN Provide odor removal capability at local sites of odor generation such as galley, head, exercise room.	
GEN Compartmentalize non-human biological specimen areas to separate experiments & crew.	
GEN Provide caution and warning signal and alarm system for hazardous conditions.	132(C-4-50; 51)
GEN Provide a means of removal of contaminants down to safe levels for 24 hr. continuous exposure. (e.g., catalytic burner, HEPA filters, other absorbant media).	

CRITICAL ASSUMPTIONSREFER. NO.

- | | |
|---|------------------------|
| o A satisfactory initial Space Station contaminant load model can be derived from previous load model data plus limited Space Station design information. | 177(p 28)
178(p 18) |
|---|------------------------|
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
201 INTERNAL ENVIRON
20107 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.5)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

-01 Station Growth Capability - Growth station operations shall include support for additional station and mission specialists and other customer personnel up to a total of eighteen.	132 (C-3, 2.1.h)
-02 Commonality - The ECLSS shall be designed to facilitate system growth through use of modular and subsystem design. The ECLSS's shall employ common hardware, software and standard interfaces which optimize benefit to the station crew.	132 (C-4, 2.1.5)

CANDIDATE SOLUTIONS

REFER. NO.

None |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

202 EXTERNAL ENVIRON

20201 RADIATION - PARTICLES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.j,3a)

Revised: 10/21/85

REQUIREMENTS

REFER. NO.

-01 <i>*(Monitor radiation dose rates and accumulated dose within Space Station, and record data.)*</i>	179,184,354 104(p 31)
-02 <i>*(Monitor dose rates and short-term accumulated doses to each crewmember/visitor, and keep exposure records.)*</i>	179
-03 <i>*(Windows shall provide attenuation of external ionizing radiation to allowable limits (refer to 10701-03).)*</i>	179,354
-04 <i>*(Provide TBD shielded volume for radiation-sensitive materials.)*</i>	354
-07 Minimize crew radiation dose levels and keep accumulated doses below allowable levels during all activities.	179 104(p 31) 180

CANDIDATE SOLUTIONS

REFER. NO.

GEN Determine radiation shielding thickness requirements for each radiation type, based on crew dose allowables & current radiation flux data.	
GEN Study means to minimize total radiation shielding mass (partial body/clothing/chair shields for individual crew vs. vehicle shields.)	
01 Provide fixed active and passive dosimeters mounted in each crew's quarters, wardroom, workstation, & cockpit/control room. Read out active dosimeters dose rate and accumulated dose in rad units. Obtain passive dosimeter readout once per week or as appropriate, in terms of flux & LET spectrum as well as rads. Consider use of dedicated automated electronic data processing system.	

- 02 Provide wearable, readable personnel dosimeters for daily cumulative radiation dose for all crew and visitors. Provide means of records keeping.
- 03 Coordinate window shielding design with other radiation protection work to achieve less than allowable dose levels.
- 04 Coordinate with other Space Station shielding requirements/design.
- 07 Schedule EVA's considering space radiation environment.

CRITICAL ASSUMPTIONSREFER. NO.

- o Assume 28.5 degree inclination and orbit of no higher than 500 Km. A polar orbit would require new considerations for this Element.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
202 EXTERNAL ENVIRON
20202 TRAPPED PROTONS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1-j.3a)

Revised: 10/10/85

REQUIREMENTS

REFER. NO.

-01 *(Monitor trapped proton flux and energy flux | 179
and energy spectrum internal to the Space
Station and record data.)* |

CANDIDATE SOLUTIONS

REFER. NO.

01 Provide fixed active dosimeter system internal |
to the Space Station, reading proton flux and |
spectrum (use differential shielding); read out |
multiplexed in Space Station. Provide record |
keeping system. |

CRITICAL ASSUMPTIONS

REFER. NO.

o Assume a 28.5 degree inclination and orbit of
no higher than 500 Km. A polar orbit would
require new considerations for this Element.

* An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.

2 CREW SUPPORT
202 EXTERNAL ENVIRON
20203 TRAPPED ELECTRONS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.j.3a)

Revised: 10/10/85

REQUIREMENTS

REFER. NO.

None

|||

CANDIDATE SOLUTIONS

REFER. NO.

None

|||||

CRITICAL ASSUMPTIONS

REFER. NO.

- o Assume a 28.5 degree inclination and orbit no higher than 500 Km. A polar orbit would require new considerations for this Element.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

202 EXTERNAL ENVIRON

20204 HIGH-Z, HIGH-E PARTICLES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.j.3a)

Revised: 10/10/85REQUIREMENTSREFER. NO.

-01 **(Monitor accumulated fluence and LET spectrum of high-Z high-energy (HZE) cosmic ray particles within the Space Station living/working areas.)**

180,181,182
104(p 31)CANDIDATE SOLUTIONSREFER. NO.

01 Provide fixed and personal passive devices to record fluence & LET spectrum of high-Z particles in crew's quarters, wardroom, work-station and cockpit/control room and crew persons bodies. Provide on-board readout capability. Readout periodically in orbit and record data.

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
202 EXTERNAL ENVIRON
20205 SOLAR FLARES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.j.3a)

Revised: 10/10/85

REQUIREMENTS

REFER. NO.

-01 *(Protect human occupants of Space Station from excessive exposure to solar flare event radiations.)*	179,180 132(C-4-51)
-02 *(Provide contingency plans for crew protection during large solar flare events.)*	179 132(C-4-51) 104(p 31)

CANDIDATE SOLUTIONS

REFER. NO.

01 Determine probabilities for solar flare events having specific proton flux vs. time and event fluence/spectra as basis for risks vs. shielding trade. Study "safe haven" concept for crew protection. Provide a communication link to solar flare warning/alert network.	
02 Study mission options and scenarios; preplan how to rearrange massive equipment in Space Station to provide additional shielding (perhaps by computer modeling). Investigate feasibility of medical prophylaxis and/or treatment for alleviation of radiation syndrome effects. Coordinate all these studies to develop optimum plans.	

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

202 EXTERNAL ENVIRON

20206 ULTRAVIOLET/INFRARED

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.j.3b)

Revised: 10/10/85REQUIREMENTSREFER. NO.

-01 Protect crew from excessive levels of solar UV, visible and infrared radiation per American Council of Government Industrial Hygienists, Physical Agents in the Work Environment (1984). | 183
|
|
|

CANDIDATE SOLUTIONSREFER. NO.

01 Attenuate solar UV, IR, and visible radiation in spacecraft windows to occupational safe levels. |
|
|

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
202 EXTERNAL ENVIRON

20208 MICROMETEOROIDES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.3.1)

Revised: 10/10/85

REQUIREMENTS

REFER. NO.

-01 **(Protect crew by TBD methods from effects of ISSS
a TBD acceptable fraction of all micrometeor-
oides.)**

CANDIDATE SOLUTIONS

REFER. NO.

01 Provide micrometeoroid shields; coordinate
with radiation shielding.
Study "safe haven" concept for micrometeoroid
protection; coordinate study with solar flare
protection requirements; examine size-frequency
distribution to establish an allowable risk
level.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.

2 CREW SUPPORT

202 EXTERNAL ENVIRONMENT

20210 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.3.1)

Revised: 10/10/85

REQUIREMENTSREFER. NO.

-01 **(Provide means of adding space radiation shielding if Space Station program growth results in increased particle fluence.)**

|172,180
|132(C-4-51)
|104(p 31)
|

CANDIDATE SOLUTIONSREFER. NO.

01 Study potential growth options for development of appropriate means of adding radiation protection.

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|

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
202 EXTERNAL ENVIRON
20212 GROUND SUPPORT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.3.1)

Revised: 10/10/85

REQUIREMENTS

REFER. NO.

-01 <i>*(Provide advance warning of solar flare events.)*</i>	132(C-4-51)
-02 <i>*(Provide current debris data per TBD.)*</i>	355

CANDIDATE SOLUTIONS

REFER. NO.

01 Establish/link into established NOAA sunspot/ solar flare watch and communications network.	
02 Maintain link with NASA/AF debris data base.	

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
203 INDUCED ENVIRON (Int/Ext)
20302 ELECTROMAGNETIC

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.j.3(b)(2))

Revised: 10/10/85

REQUIREMENTS

REFER. NO.

-01 <i>*(Communication/radar antennas and other RF producing devices shall be designed to maintain levels below ACGIH standards in Space Station living/working spaces.)*</i>	132(2.2.10.1.j.3(b)(2))
-03 Design equipment that limits broad band RF/microwave electric & magnetic field strengths to meet ACGIH Standards.	186,155

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

REPORT FORMAT 3.1

DESIGN/OPERATIONS REQUIREMENTS

2 CREW SUPPORT
203 INDUCED ENVIRON (Int/Ext)
20304 LASER

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.j.3(b)(1))

Revised: 10/10/85

REQUIREMENTSREFER. NO.

-01 **(Design/operate communication/ranging lasers on Space Station so that neither direct nor reflected irradiance levels in the work/living spaces exceed ACGIH Standards.)**
|132(2.2.
|10.1.j.3(b)
|(1))
|187
|(Tables 3-7)
|188
|
|
|
|

CANDIDATE SOLUTIONSREFER. NO.

None

|
|
|

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
203 INDUCED ENVIRON (Int/Ext)
20305 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1j)

Revised: 10/10/85

REQUIREMENTS

REFER. NO.

-01 **(Provide crew protection from TBD synergistic effects of system growth, e.g., contamination, debris, radiation. etc.)**

353
|
|

CANDIDATE SOLUTIONS

REFER. NO.

None

|

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

204 AREA LIGHTING

20401 ILLUMINATION & DISTRIBUTION RQMTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1)

Revised: 10/24/85REQUIREMENTSREFER. NO.

- 01 The intensity of the general illumination lights shall be a minimum of 20 ft-c(186 Lux). The lighting level shall be measured on the primary surface using a ft-candle meter, or a photometric, using a 98% reflectance magnesium oxide (MgO) disk. The intensity of the general illumination lights after 4800 hours of operation shall not be less than 60 percent of the original intensity. Distribution of light shall not exceed a ratio of 7:1. | 352 (pp. 7.2.3)
- 02 Minimum lighting levels and direction of illumination shall be specified in all areas and for specific tasks, consistent with JSC-19517, (J8400037); JSC-SC-L-0002A, (J8400080); and MIL-STD. 1472, (J00032). | 352
- 03 Combined natural and artificial illumination provisions shall accommodate physiological health criteria. | 162,163,164, 165,308

CANDIDATE SOLUTIONSREFER. NO.

None |

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
204 AREA LIGHTING
20402 GLARE CONTROL

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

- | | |
|--|----------------------|
| -01 Locate light sources away from normal line of sight. | 189(pp. 7.2) |
| -02 The light source shall be recessed to the greatest extent possible and shall provide even illumination from its location. The fixture shall be designed to direct light into the desired areas with no visual discomfort to the crewmembers. | 189
 (pp. 7.2.1) |
| -03 Provide surface reflection for ceilings of 60-70% and for walls of 30-60%. | 103 |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

204 AREA LIGHTING

20403 FIXTURES/LUMINAIRES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1)

Revised: 9/24/85

REQUIREMENTSREFER. NO.

- | | |
|--|------|
| -01 Provide distributed luminaries with a color temperature of 2700 degrees K or higher, as needed for special applications. | 1352 |
| -02 Provide fixtures/luminaires whose exposed surfaces do not exceed 45 degree C (113 degree F) when operated at maximum output. | 131 |
| -03 Portable lights shall be provided. | 131 |
| -04 The light source shall be incandescent or fluorescent lamps and shall be illuminated within one second after being energized. The light source shall be recessed to the greatest extent possible and shall provide even illumination from its location. The fixture shall be designed to direct light into the desired areas with no visual discomfort to the crewmembers. | 189 |
| -05 Fluorescent lights shall be protected from breakage and escape of mercury. | 190 |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
204 AREA LIGHTING
20404 CONTROLS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-----|
| -01 Locate light controls at convenient locations throughout the Space Station in accordance with usage requirements. | 132 |
| -02 Lighting controls shall be provided with an on-off and continuously variable dimming-to-low level control capability. Lowest level shall remain visible. | 189 |
| -03 Exterior light controls shall be located both at the exterior and interior of the Space Station at convenient locations. | 132 |

CANDIDATE SOLUTIONS

REFER. NO.

GEN Provide proximity on/off switches for energy conservation.	
--	--

CRITICAL ASSUMPTIONS

REFER. NO.

o Robotics will be used for some EVA operations.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

REPORT FORMAT 3.1

DESIGN/OPERATIONS REQUIREMENTS

2 CREW SUPPORT
204 AREA LIGHTING
20405 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1)

Revised: 9/24/85

REQUIREMENTSREFER. NO.

-01 Lighting system growth shall be consistent with periodic upgrades and previous installations. 1352
|
|

CANDIDATE SOLUTIONSREFER. NO.

None

|

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

205 ACOUSTICS

20501 NOISE CONTROL

CROSS REFERENCE TO RFP PARAGRAPH No: C-4 (2.2.10.1a)

Revised: 10/10/85REQUIREMENTSREFER. NO.

For detailed specifications refer to the Document by the National Academy of Science, Committee on Hearing & Bioacoustics (CHABA). This document will be available in draft form November 1985 and in final form January 1986.

- 01 **(Equipment noise standards shall be applied.)** | 159(p 166)
| 155
- 02 **(Equipment shall be mounted and located to reduce noise in the manned station.)** | 132(C-4-53)
| 377(p 116)
- 03 System designs shall include effective noise control provisions. | 192(p 14)

CANDIDATE SOLUTIONSREFER. NO.

- 01 Equipment Specifications | 192(p 14,
- Determine source sound power levels. | 16, 34)
- Determine noise paths, structural and airborne
- Procure equipment based on noise standards)
- 03 Module Design | 192(p 13,16)
- Assign a noise control authority (acoustical engineer).
- Predict module air space noise level.

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

205 ACOUSTICS

20502 PHYSIOLOGICAL EFFECTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4 (2.2.10.1a)

Revised: 10/10/85

REQUIREMENTSREFER. NO.Use of terms

Leq = Average of noise levels over specified (x) hours.
LA = Noise level measured in dBA.
ODD/LDD = Observed daily duration of noise (divided by) Limited daily duration.
SIL = Speech Interference Level
AI = Articulation Index
OBL = Octave Band Level

- | | |
|---|-----------------------------|
| -01 LA shall be less than or equal to 90 dBA at 125 Hz to 78 dBA at 8000 Hz. | 197(p 5) |
| -03 Narrow band (tone) components shall be 10dB less than OBL random noise. | 195(p 1) |
| -04 Impulse or impact noise shall not exceed 140 dBC. | 203(p 5),
201(p 127-135) |
| -05 Ear protection devices shall be provided for use during contingency conditions of exposure to noise levels greater than 85 dBA. | 201, 199 |
| -06 Leq (24) shall be less than or equal to 50dBA. | 132(C-4-53) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

205 ACOUSTICS

20503 PSYCHOLOGICAL EFFECTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4 (2.2.10.1a)

Revised: 10/10/85REQUIREMENTSREFER. NO.

-05 Intermittent noises shall be minimized.	1193(p 135)
-07 Infrasound level shall be less than 120dB SPL at 1-16 Hz.	204(p 35)
-08 Ultrasound level shall be less than 105 dB SPL above 20k Hz.	204(p 35)

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

205 ACOUSTICS

20504 FUNCTIONAL TASK/WORK AREA ENVIRONMENTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1a)

Revised: 10/10/85

REQUIREMENTSREFER. NO.

-01 Sleep/Rest Area

a. Masking noise is not a preferred solution, but where utilized it shall not exceed 55 dBA. Masking noise level and shape shall be under control of crewmembers.

193(p 135)

b. LA shall be less than or equal to NC 40 contour, but greater than NC 25 contour.

193(p 134)

195(p 1)

201(p 129)

d. No anticipated impulse noise shall exceed background by more than 10dB.

204(p 37)

-02 Dining Area - sound level shall be within 40 to 60 dBA.

204(p D-54)

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

206 SAFETY

20601 CREW SAFETY

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.2) & C-4(2.1.11)

Revised: 9/24/85REQUIREMENTSREFER. NO.

- | | |
|--|----------------------------|
| -01 Emergency detection and control of hazardous conditions shall be provided. | 132(C-4,
 pp 2.1.11) |
| -02 Provide habitable conditions for the crew for 28 days accessible from anywhere in station without EVA. | 132(C-4,
 pp 2.1.11.2) |
| -03 Provide orbiter berthing capability for shirt sleeved crew rescue. | 132(C-4,
 pp 2.1.11.2) |
| -04 All failures of safety critical SSPE systems shall be annunciated to the flight and ground crew. | 132(C-4
 pp 2.1.11.2) |
| -05 Exposed surfaces within modules shall not exceed a temperature of 45 deg. C (113 deg. F) and a low temperature not less than 16 deg. C (61 deg. F). | 132(C4,
 2.1.11.2h) |
| -06 The crew shall not be exposed to electrical power leads. Ground-fault protection shall be provided for circuitry or power distribution busses routinely accessible by the flight crew. | 132(C4,
 2.1.11.2k) |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|--|--|
| 01 Emphasis should be placed on rapid automated detection and automated or manual, as appropriate, control of hazardous conditions such as fire, toxic contamination or depressurization. Special procedures should be provided for recovery from emergency conditions and restoration of safe conditions. | |
| 02 Provide dual ingress/egress capability, widely distributed systems and stores, high commonality of function between modules and capability to isolate effected modules/areas. | |

- 03 Each module should have access to an STS
compatible berthing port.

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CRITICAL ASSUMPTIONS

REFER. NO.

- o It is assumed that crew safety will be considered early in the Definition and Preliminary Design so that the order of design precedence (Ref. 132, C-4, Para. 2.1.11.1) will be fully implemented.
- o All mission payloads and SSPE will be designed fail-safe so that any caustic/corrosive liquid spillage will be contained from spreading (protecting IVA crew and EMU suits).
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

207 HEALTH MAINTENANCE

20701 PHYSIOLOGICAL CONDITIONING/COUNTERMEASURES

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.2.2.4.11);C-4(2.2.10.2.g)

Revised: 9/24/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 A crew quarters for each crewmember shall be provided conducive to quality sleep, and scheduling shall allow adequate time for sleep.	205(Ch.9) 214,216,361, 362,132(C-4-55)
-02 <i>*(Equipment, facilities, supplies, timelines & procedures shall be provided to support effective cardiovascular, musculoskeletal, and blood & fluid redistribution countermeasures. These shall include as a minimum physical exercise facilities, passive stressor devices, and adequate fluid/dietary regimens as countermeasures.)*</i>	205(Ch.18) 104,206,207, 208,210,211, 132(C-3-11) 132(C-4-56) 132(C-13) 360(Ch. 8)
-03 <i>*(Equipment, procedures and scheduling shall be provided to minimize the effects of Space Motion Sickness (SMS) on individual crewmembers.)*</i>	(205(Ch.8); 104,206,207, 209,218
-04 The exercise area shall accommodate a minimum of two crewmembers exercising simultaneously.	132(C-3-12)
-05 <i>*(Competitive TBD sports/games shall be developed in order to promote crew well being.)*</i>	219,220,221
-06 <i>*(Pharmacological methods, [TBD] including oral rehydration, shall be provided to increase the body's total fluid volume, especially just prior to reentry to Earth's gravitational field.)*</i>	205,208,218 375,376
-07 <i>*(An optimum combination [TBD] of countermeasures should be developed to provide effective cardiovascular and musculoskeletal conditioning, tailored to the individual, and minimizing time spent on boring/monotonous exercise.)*</i>	205,104,215
-08 <i>*(TBD hours per day, but not less than 1 hour/day, shall be allocated for physiological</i>	205(Ch 18) 205,104,207,

<i>conditioning/exercise.)*</i>	219,222
<i>-09 *(TBD countermeasures for SMS shall be provided, including TBD autogenic biofeedback training protocols, prophylactic medication, and/or minimum workload scheduling during early days of mission.)*</i>	205(Ch 8) 104,206,207, 215,216,217, 218,238,239, 240,241

CANDIDATE SOLUTIONSREFER. NO.

01 Private crew quarters should be provided for each crewmember, with appropriate sleep restraints, acoustically isolated, controllable lighting, temperature, and ventilation, and a minimum needed hours allotted on the timeline for sleep.	132(C-4-56) 100,102,128 205(Ch.9)
02 Provide a combination of active and passive devices which provide cardiovascular loading and skeletal muscle and bone loading.	205(Ch.18); 104,206,207, 219,220,224, 225,226
A. ACTIVE DEVICES	
(1) Equipment for exercising the cardiopulmonary system by engaging large skeletal muscle masses (aerobic exercise) as partial countermeasure to cardiovascular deconditioning (CVD) and muscle atrophy;	219,220,221 223,224,226 229,227
(a) Treadmill. With proper bungee loading can provide cardiorespiratory stimulation and foot-strike loading which can partially counteract calcium wasting by stimulating the skeletal system.	131(p 200)
(b) Bicycle ergometer. Provides adequate cardiorespiratory stimulation but no skeletal loading.	131(p 200)
(c) Cross country skiing, simulated "vertical" climbing exercise devices, and/or TBD exercise device, which utilize both upper and lower body skeletal muscle groups, shall be provided.	
(2) Equipment for placing tension stress upon specific skeletal muscle groups (an aerobic exercise) in order to counter "disuse atrophy" of skeletal muscles caused by micro-g shall be provided as part of Health Maintenance Facility (HMF). Isotonic and isokinetic exercise shall be provided, e.g., capstan-type, chest-expansion, etc.	
B. PASSIVE DEVICES	
(1) LBNP (lower body negative pressure) equipment to sequester body fluid in the lower extremities as a partial countermeasure to fluid loss and CVD shall be provided, including both fixed and ambulatory versions.	226

- | | |
|---|-------------------------------------|
| (3) "Anti-gravity" garments to counteract the +Gz/footward movement of fluid shall be provided. | 205,104,206,
210,211,212,
218 |
| 03 Provide supplies, protocols and procedures which have been proven to counteract loss of electrolytes, bone and muscle mass loss, & to increase body fluid volume prior to reentry. | |
| (a) The food system should provide adequate fluid, caloric intake, and nutrients known to counteract loss in muscle mass and electrolytes. | 131(p 287-294) |
| 04 Exercise devices should be integrated in a facility (HMF) which permits the use of aerobic exercise devices by two or more crewmembers simultaneously, so as to provide a setting for both exercise and socialization. | 132(C-3-12)
131(p 199) |
| 05 Exercise devices should be instrumented to determine workload and integrated into the computer system of HMF so downlinking of exercise parameters, including physiological data can be accomplished. | 155 |

CRITICAL ASSUMPTIONSREFER. NO.

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| o Adequate amounts of quality sleep is essential to physiological health. | 228,230 |
| o Adequate fluid and dietary intake is essential to physiological health; adequate caloric and nutrient content in the diet are necessary for 90 day flight duration to ensure safe return to earth. | 205 |
| o Cardiovascular and musculoskeletal countermeasures are necessary in 90 day flight duration to ensure safe return to Earth. | 205(Ch.18),
104,206,207
208,210,211,
222,223,225 |
| o Vestibular (SMS) countermeasures are desirable during the first week of the mission | 205(Ch.8)
104,206,209 |
| o Some type of cardiovascular loading is required to provide cardiovascular conditioning. | 208,231,219
220 |
| o Some type of muscle loading is necessary to prevent/minimize loss of muscle & mass/muscle atrophy. | 211,219 |
| o NASA will not attempt to preselect individuals who are not susceptible to SMS. | 236,237 |
| o All functions of Health Maintenance Facility | 131,132(C- |

(HMF) will be located in the same part of 4-56)
the same habitable Space Station module at
IOC.

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

207 HEALTH MAINTENANCE

20702 PHYSIOLOGICAL STATUS MONITORING

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.2.2.4.11);C-4(2.2.10.2g)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

-01 The capability for status monitoring shall be provided. Functions shall include:
Private medical conferences with ground-based medical personnel.

|205,104,206,
|207,215,216,
|234
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CANDIDATE SOLUTIONS

REFER. NO.

GEN Physiologic status monitoring apparatus for personal wear should include unambiguous parameters such as, ECG/HR, body temperature, and respiration rate. Monitoring with Station-mounted apparatus should include a wide array of sophisticated parameters such as systolic/diastolic blood pressure, non-invasive right arterial pressure, cardiac output, ejection fraction, peripheral vascular integrity, blood gases, PH, respiratory pressures and flows.

|205,104,215,
|221,225
|132(C-4-56)
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CRITICAL ASSUMPTIONS

REFER. NO.

- o Normal ranges of many physiological parameters will change in micro-g. 205,104,208, 210,211
- o Recovery time from physical work or other stressful situations back to "micro-g normal" may be different than Earth-based recovery time for similar stresses. 215
- o Physiologic status monitoring functions will be an integral part of HMF at IOC. 232, 132(C-4-56)
- o Space Station will contain a dedicated state-of-the-art medical data management and communication system at IOC. 215

- o At IOC, Space Station may not have a physician 206 onboard.
- o Ground-to-Space Station communications may be lost or garbled.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

207 HEALTH MAINTENANCE

20703 DISEASE PREVENTION

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.2.2.4.11.,pp.);C-3(2.6b);
C-4(2.2.10.2.g)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

-02 <i>*(Preflight procedures shall be implemented to minimize/eliminate exposure of flight crews to contagious diseases.)*</i>	214,238,239, 240,241
-03 The station shall provide capability to monitor the microbiological environment, including the atmosphere, food/water system, and waste management system.	132(C-4-51)
-04 The station shall carry equipment/supplies as needed to disinfect its habitable volumes, and assure safe storage/preservation of food and water, and deactivation of human waste.	132(C-4-50;51)
-05 The station shall provide capability to monitor and remove trace contaminants in the atmosphere.	132(C-4-50)
-07 <i>*(The station shall provide the capability for bioisolation between life sciences research specimens (e.g., animals, plants) and the rest of the habitable atmosphere.)*</i>	132,206,207, 215,233

CANDIDATE SOLUTIONS

REFER. NO.

02 Space Station program should implement a preflight health stabilization program analogous to those of Apollo & Skylab.	213,214,236
03 Provide microbiological detection kit including swabs, culture media, incubator, microscope, and automated microbiological detection instrumentation with capability for detection of specific pathogens.	132(C-4-50; 51) 241
07 Provide a Life Sciences Research Module whose plant and animal holding facilities are supported by a separate ECLSS during normal operations, and whose working space is filled with air from the station ECLSS.	132(C-13)

- | | | |
|----|--|------------------|
| 07 | Provide a means to isolate the entire LSRM from the rest of the station during specimen manipulation or contingency operations. | 132(C-13;C-4-51) |
| 07 | Provide equipment and supplies e.g., garments, masks, shower, to prevent or minimize cross-contamination between human & animal species. | |

CRITICAL ASSUMPTIONSREFER. NO.

- | | | |
|---|---|-------------------------|
| o | A preflight health stabilization program will be implemented. | 238,239,240,
241,242 |
| o | A life sciences payload including living research specimens will be one of the customer accommodations. | 104,206,207,
215,235 |
| o | International participants will be included in Space Station missions. | 132(B-9.13) |
| o | Crews may overlap in time. | 132(C-3-6) |

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
207 HEALTH MAINTENANCE
20704 ACCIDENT PREVENTION

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.2.2.4.n)

Revised: 9/24/85

REQUIREMENTS

REFER. NO.

None

CANDIDATE SOLUTIONS

REFER. NO.

GEN Work scheduling should include consideration assessment of decrements in hearing or vision thresholds, reaction time, hand-eye coordination & other sensorimotor performance changes over time.

GEN A workload assessment program should be implemented to develop objective measurements and to test hypotheses as to the optimum combination or sequence of work types, considering 0-g recovery time (ref. 2070202).

GEN The same measurement techniques used for ground based workload assessment should be used inflight as indicators of performance vs. mission duration.

244,245,246,
248,249,250

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
207 HEALTH MAINTENANCE
20705 STRESS MANAGEMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.2.2.4.11)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

-01 Crew shall be provided with a stable schedule of work, leisure, motor activity and sleep.	251,252,265 277,284,285
-02 <i>*(The galley shall be capable of providing a balanced diet.)*</i>	253,254,255 260
-03 <i>*(Countermeasures are needed for the physiological concomitants of long-term stress.)*</i>	205(Ch.18); 252,253
-04 Adequate time shall be allocated for crew accomplishment of given tasks.	
-07 Crewmembers shall have the opportunity for regular private contact with family members and friends.	270,129,282, 283,284

CANDIDATE SOLUTIONS

REFER. NO.

GEN Develop procedures for communicating information to crewmember in the event of a family emergency.	129
GEN Crewmembers should have periodic private communication link with their flight surgeon.	284
01 a. Develop mission schedule which maximally accommodates established crew circadian rhythms. b. Required circadian rhythms be phased in prior to start of mission. c. Provide equipment and opportunity for routine exercise.	251,252,265
01 Flexible scheduling shall incorporate a diversification of activities: mission work, personal work, group recreation, individual recreation, privacy, rest, and sleep.	
04 a. Design flexibility in mission schedule for crew-initiated extension of task time, if	265,266,267, 268

- required.
- | | |
|--|-------------|
| b. Allow crew to participate in the planning and scheduling of tasks to a maximum extent. | 247,269,277 |
| c. Establish and update database on time required for task accomplishment to support mission planning. (Refer to 306) | |
| 07 a. Provide periodic access to a private communication (audio & video) link between crew-members and their families and friends. | 270,129,284 |
| b. Transport personal mail to resident crew members as part of space shuttle visits. (Refer to 308) | |

CRITICAL ASSUMPTIONSREFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

208 MEDICAL CARE

20801 DIAGNOSIS & TREATMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.2.2.4.11);C-4(2.2.10.2.g)

Revised: 11/4/85

REQUIREMENTSREFER. NO.

- 01 a. **(The Space Station shall provide capability for routine and emergency diagnosis including all of the instrumentation equipment, lab supplies, and pharmaceuticals of the Shuttle Medical Kit, plus an inflight laboratory capability for routine hematology, immunology, clinical chemistry, urinalysis & microbiology, equipment for standard physical examinations, basic physiological monitoring instrumentation (HR/EKG,BP,Temp), & some form of diagnostic imaging.)** 104,206,232, 132(C-4-56, 57),288,205, 370
- b. At IOC, station shall have onboard capability (equipment, facilities, skills) for the following: 104,206,207, 289,290
- a. IV Fluids/Catheterization 371,372
 - b. Minor Surgery
 - d. Local Anesthesia
 - e. Burns treatment
 - f. Bends recompression capability (3 ATM)
 - g. Respiratory equipment (oxygen, airways, laryngoscope, ventilation)
 - h. Medical Imaging System
- 02 The station shall provide capability for routine and emergency medical treatment including all of the capabilities of the Shuttle Medical Kit plus basic cardiac and pulmonary life support capability. 104,206,288, 205,370, 132(C-4-56, 57)
- 03 A comprehensive medical checklist shall be provided including diagnostic/treatment for routine and emergency conditions. 104,206,288, 132(C-3-11) 372
- 04 A basic dental diagnostic & treatment capability shall be provided. 104,371,372
- 05 **(At least one crewmember shall have [TBD] minimum medical skills.)** 291,292

CANDIDATE SOLUTIONSREFER. NO.

GEN	Allow over-the-counter and previously prescribed medications in crewmembers individual inventories (wardroom viz HMF).	238,241
01	Provide the required diagnostic capability, incorporating state-of-the-art automated clinical chemistry instrumentation, automated microbiological detection/identification/quantification instruments, wireless physiological monitoring systems, and TBD medical imaging system.	104,232,132(C-4-55,56)
01	Perform analysis to identify possible medical emergency and catastrophic scenarios which are judged to require an STS rescue mission.	
01	Perform analysis of probabilities of disease/injury based on crew size, age, sex, assigned mission operations, vs adverse consequences of non-treatment vs. cost of providing additional treatment capability.	
02	Provide the required treatment capability in a dedicated area of the initial module with provisions for growth in pharmaceutical inventory, and provision for isolating the area from other crew activities, and sterilizing it.	373,104,132
03	Provide a fixed multipurpose applications console in the HMF area.	214,288,104,132
04	Provide dental capability similar to Skylab at IOC; augmented capability with a dental restraint system, more extensive equipment and supplies, and one crewmember given additional dental training for growth station.	104,214

CRITICAL ASSUMPTIONSREFER. NO.

o	Each crew will have at least two crewmembers trained as a paramedic/EMT.	104,206,291
o	All crewmembers will be trained in basic routine medical care ("first aid").	241
o	A physician on Earth will be on call 24 hr/day for emergency consultation.	
*	<i>An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.</i>	

2 CREW SUPPORT

208 MEDICAL CARE

20804 MEDICAL RECORDS, COMM, & INFO MGMT

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.2.2.4.x,11; 3.2.2.5);
C-4(2.2.10.2.g)

Revised: 9/25/85

REQUIREMENTSREFER. NO.

- 02 **(A separate Medical DBMS shall be provided to manage health information (medical records, trend analysis, health maintenance and bio-medical research scheduling assistance, and medical checklists.))** | 132(C-4-55)
| 294(p 20-
| 21;86-87;147-
| 148)293
| (p 5-23 to
| 5-44)
- 03 There shall be a private medical communication link to the ground for routine, emergency, and/or other medical consultation including voice, video and data. | 104,206,207
- 06 Routine data input and retrieval shall be minimally intrusive on crewmembers schedule and attention. | 294
- 07 Medical data shall be protected against loss by system malfunction or failure. | 294
- 08 MDBMS must accomodate pre-mission medical records on crewmembers as well as relevant data collected during the mission. | 232
- 10 MDBMS/IDMS boundaries should be invisible to users to minimize training requirements and probability of error. | 293
- 11 Security provisions shall permit data access only by authorized users. | 293(p 5-70)

CANDIDATE SOLUTIONSREFER. NO.

- GEN The same relational DBMS and compatible data should be employed in all systems. | 293(p 5-71)
- 02 Provide standard pre-defined information retrieval requests keyed to routine requirements and high-probability medical emergencies. |

03	Provide for routine downloading of data to JSC MDMS.	238,241
06	Provide maximum degree of automation of inputs via non-keyboard input devices and interfaces with instrumentation.	
06	MDBMS and IDMS should use same query language data input and update processors and DBMS.	
07	System and storage media must be space-hardened (radiation, shock & vibration, additional cooling).	
10	Relevant data fields stored on the IDMS (e.g., crew schedule, environmental monitoring should be accessible by the MDBMS.	
11	Multiple levels of user access to data should be defined and enforced through the use of passwords, voice recognition devices, etc.	

CRITICAL ASSUMPTIONSREFER. NO.

- o Regardless of level of sophistication of inflight medical capability, ground support for records, analysis, & expert consultation will be available during a mission.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

REPORT FORMAT 3.1

DESIGN/OPERATIONS REQUIREMENTS

2 CREW SUPPORT

208 MEDICAL CARE

20805 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.2.2.4.11);C-4(2.2.10.2.G)

Revised: 9/25/85

REQUIREMENTSREFER. NO.

-01 *(Diagnostic and treatment capability shall be
TBD augmented as the crew size increases; with
changing mission characteristics/duration/
risk.)*

104,206,207

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.

2 CREW SUPPORT

209 RECREATION

20901 TYPES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.f)

Revised: 10/24/85REQUIREMENTSREFER. NO.

-01 Provision shall be made for varied recreational activities.	131(p 151,73 128(p 92) 296(p 9, 41,48),298 (p 26,45) 130(p 64) 295(p 64, 65,113) 129(p 52,53) 297(p 17)
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CANDIDATE SOLUTIONSREFER. NO.

GEN Provide the kind of music each crewmember desires (private and public listening).	131(p 73)
GEN Provide game materials and provisions for parties.	129(p 52) 131(p 151)
GEN Provide movies, books, music (passive). Provide computers, cameras (active). Provide for individually selected projects.	131(p 73, 151) 129(p 52, 53) 128(p 92) 130(p 154- 156) 295
01 Provide ability for writing, drawing, music (listening, singing, playing), two-way trans- missions (families, friends, news, concerts) computer use (games, word processing, science) picture-taking ability, hobbies, reading, off-duty science experimenting, video watching educational programs.	131(p 151, 73) 129(p 52, 53) 130(p 154, 15) 295, (p 106-114)

CRITICAL ASSUMPTIONSREFER. NO.

- o There will be adequate room to store activity equipment and materials.
- o Some activities will be specially designed for space conditions.
- o Time will be allowed for recreation.
- o There will be adequate volume and space for activities.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

209 RECREATION

20902 FACILITIES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.f)

Revised: 9/25/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-02 There shall be provision for group listening to music.	295(p 64)
-03 The capability for individual listening to music shall be provided.	295(p 64)
-05 There shall be an area where crewmembers can carry on private conversations with family and friends on the ground, and each other.	295(p 150)
-06 Leisure activities shall not be confined to one specific space.	296(p 59)
-07 <i>*(The capability shall be provided where the entire crew can meet as a group or in smaller groups at the same time and participate in various activities.)*</i>	344
-08 <i>*(The capability for individualized activities, i.e., reading, writing, music shall be provided.)*</i>	344
-09 The capability for direct Earth & Space observation from different areas shall be provided.	131(p 151)
-10 <i>*(An area shall be provided for private and/or group viewing/listening to video and audio tapes.)*</i>	344

<u>CANDIDATE SOLUTIONS</u>	<u>REFER. NO.</u>
GEN Design to accommodate such activities as: writing, computer, two-way transmissions, nerf balls, cameras.	131(p 151) 130(p 155)
GEN Provide an area for group listening to music (e.g., the wardroom).	295(p 64)

CRITICAL ASSUMPTIONSREFER. NO.

- o There will be adequate room to store varied equipment and supplies.
- o Some areas will be multiple-purpose (e.g., wardroom for music, eating, games; private quarters for listening to music, sleeping).
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

209 RECREATION

20903 EQUIPMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.f)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

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|--|---------|
| -08 The capability shall be provided to accom- | 344,155 |
| modate crew preference off-the-shelf personal | |
| recreation equipment. | |
| -09 Equipment shall be provided with the | 344,155 |
| capability to receive ground transmission of | |
| first-run movies, educational training, music, | |
| news, TV shows, specials, etc. | |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|---|--------------|
| GEN Design to accommodate such things as: | 129(p 52-53) |
| books, video recorder, video cassettes, | 131(p 151) |
| computer, computer software, two-way communi- | 128(p 92) |
| cation system, writing utensils, cassette | 130(p 154- |
| recorder, music cassettes, table games, dark- | 156) |
| room apparatus, cameras, film, stereo sound | 295 |
| system, drawing supplies and materials, | (p 106-114) |
| sports equipment (nerf balls, etc.) | |

CRITICAL ASSUMPTIONS

REFER. NO.

- o There will be adequate room to store equipment.
 - o Some equipment will be specially designed for space conditions.
 - o Equipment will meet space qualification specifications and standards.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

209 RECREATION

20904 SUPPORT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.f)

Revised: 9/25/85

REQUIREMENTSREFER. NO.

-03 The capability to receive ground transmission of first-run movies, educational training, music, news, TV shows, specials, etc., shall be provided.

128, 130
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CANDIDATE SOLUTIONSREFER. NO.

None

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CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

209 RECREATION

20906 PLANNING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.f)

Revised: 9/30/85REQUIREMENTSREFER. NO.

-05 <i>*(Recreation equipment shall have repair capabilities and backups.)*</i>	128, 130
-07 <i>*(The capability for incorporation of new activities onboard an active station shall be provided.)*</i>	128, 130
-09 <i>*(An easy-to-store, properly labeled system for recreation equipment shall be provided and in concordance with the general stowage system.)* (refer to section 109)</i>	128, 130

CANDIDATE SOLUTIONSREFER. NO.

GEN The crew shall participate in planning and providing for recreational activities.	

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

210 PERSONAL HYGIENE

21001 BODY WASTE MANAGEMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.i)

Revised: 9/30/85

REQUIREMENTSREFER. NO.

- | | |
|---|-------------------------|
| -01 Private commode/urinal compartment and facilities shall not contaminate galley, HMF and dining area. Contamination shall include but not be limited to odor and noise. | 132(C-4-57) |
| -02 <i>*(Commode/urinal compartment shall be sized to accommodate donning/doffing and temporary stowage of clothing.)*</i> | 132(C-4-57) |
| -03 <i>*(Urinal compartment(s) and handwasher(s) shall be provided for each module.)*</i> | 133(p 89) |
| -04 Provisions shall be made for selective body cleaning after urination/defecation. | 132(C-4-57) |
| -05 Provisions shall be made for contingency collection and disposal of body waste. | 169(p 170) |
| -07 Body waste collection and management system shall be designed to prevent the return of odors, particulates, biotic contaminants, or toxicants to the Space Station environment. | 132(C-4-57) |
| -08 Body waste management system shall be designed to prevent the contamination of crew with feces and urine during use. | 128(p 40)
 299(p 8) |
| -10 Waste management facilities shall accommodate safehaven/crew growth requirements. | 155 |
| -11 Design shall accommodate contamination management and cleaning requirements. | 155 |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|---|-----------------------------|
| 04 Provide dry/wet wipes and tissue (STS Technology) | 112(p 3,4,
 5)130(p 43) |
| 04 Provide hand-washing station in each commode/urinal compartment. | 133(p 89) |

- | | | |
|----|---|-------------------|
| 05 | Provide collection bags for the contingency collection of body waste. | 169(p 170) |
| 05 | Provide contingency means (vacuum desiccation, Sky Lab Technology) for stabilization and storage of collected body waste. | 169(p 167)
300 |

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

210 PERSONAL HYGIENE

21002 WHOLE-BODY CLEANING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.i)

Revised: 10/24/85REQUIREMENTSREFER. NO.

- | | |
|---|---------------|
| -01 Whole-body shower with the following characteristics shall be provided: | |
| o Method to remove excess water from body and stall, | 131(p 52) |
| o Heated stall and dressing area, | 132(C-4-57), |
| o <i>*(Means to control water temperature)*</i> | 132(C-4-57) |
| o <i>*(Means to control water flow/usage)*</i> | 301 |
| o Method to collect/separate and recycle air and water, | 132(C-4-57) |
| o Prevention of electric shock to the crew, | 132(C-4-45, |
| o <i>*(Means to prevent CO2 build up to a TBD level.)*</i> | 46) |
| | 132(C-4-57) |
| -02 Privacy shall be provided for whole body cleaning. | 132(C-4-57) |
| -03 <i>*(A means for final body drying after showering shall be provided.)*</i> | 126(p 52) |
| -04 Provide for whole-body showering within each HAB module. | 133(p 60, 91) |
| -05 Contingency whole-body cleaning shall be provided. | 103(p 10. 16) |
| -07 <i>*(TBD water volume shall be provided to allow for a shower for each crewmember every TBD days.)*</i> | 103(p 10. 16) |
| -08 Provide hygiene quality water for whole-body cleaning. | 133(p 477) |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|---|-----------|
| 01 Provide air flow to help remove excess water from body and shower stall. | 130(p 46) |
| 01 Provide hot/cold water and a manual mixer valve for shower. | 131(p 52) |

01	Provide hand-held water spray nozzle with on/off valve.	301
03	Provide highly absorbent towels for final body drying.	130(p 45)
05	Provide wet/dry body wipes.	169(p 414)
05	Provide wash cloths and hand washing stations.	169(p 414) 133(C-4-57)

CRITICAL ASSUMPTIONSREFER. NO.

- o Provisions for whole-body cleaning will be required for all crewmembers.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
210 PERSONAL HYGIENE
21003 PARTIAL-BODY CLEANING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.i)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

- | | |
|---|-----------------------|
| -01 Hand washing station with following characteristics shall be provided: | 169(p 167) |
| o Method to remove excess water from hands basin, | 132(C-4-57) |
| o <i>*(Means to control water temperature,)*</i> | 103(p 7-2) |
| o <i>*(Means to control water flow/usage,)*</i> | 132(C-4-46) |
| o Prevention of electric shock, | |
| o Means to prevent water from escaping into the cabin environment. | |
| -02 Washing station shall be provided to accomplish washing of selected body areas after the following: | 103(p 10-16)133(p 89) |
| o Post-urination/defecation, | 132(C-4-55, 57) |
| o Post-exercise, | |
| o During medical/health maintenance, | |
| o Pre- and post experimentation, | |
| o Pre- and post meals. | |
| -03 Provide contingencies for partial-body cleaning. | 103(p 10-16) |
| -05 Provide hygiene quality water for partial-body cleaning. | 133(p 477) |
| -06 Washing stations in habitability modules shall accommodate shaving and oral hygiene. | 132(C-4-54) |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|-------------|
| 01 Provide air flow to assist in removal of excess water from hands and basin. | 301 |
| 01 Provide hot/cold water and a manual mixer valve. | 132(C-4-57) |
| | 169 (p 167) |
| 01 Provide a clear-dome enclosure for the wash station basin. | 169(p 167) |
| | 103(p 7-2) |

- | | | |
|----|---|-------------|
| 02 | Provide hand washing stations in the following module area: | 103(p 10- |
| | o Urinal compartments, | 16)133(p |
| | o Galley area, | 89),132(C-4 |
| | o Commode/urinal compartments, | 55,57) |
| | o Health Maintenance area, | |
| | o LAB modules. | |
| 03 | Provide wipes (STS Technology): | 103(p 8-4) |
| | o Dry wipes, | 112(p 3,4, |
| | o Wet wipes, | 5)130(p |
| | o Biocide wipes. | 43) |

CRITICAL ASSUMPTIONSREFER. NO.

- o Provisions for partial-body cleaning will be required for all crewmembers.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

210 PERSONAL HYGIENE

21004 BODY GROOMING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.i)

Revised: 9/25/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Provisions shall be made for crewmembers to shave body hair.	103(p 10-16)
-02 Provisions shall be made for crewmembers to trim/cut hair.	103(p 10-16)131(p 50)
-03 The capability shall be provided for crew oral hygiene.	131(p 50)
-04 The capability shall be provided for collection of body hair and nails.	131(p 50)
-05 <i>*(Each crewmember shall have a personal hygiene kit containing a supply of personal items for skin and dental care, shaving, hair grooming, nail care, & body deodorizing.)*</i>	103(p 10-16)117(p 4,5)
-06 Personal grooming items/equipment shall not present or create a hazardous condition.	103(p 7-2)

<u>CANDIDATE SOLUTIONS</u>	<u>REFER. NO.</u>
01 Provide facilities (wash station) for wet shaving using conventional safety razor.	131(p 50) 117(p 19)
01 Provide equipment/facilities for dry shaving using conventional re-chargeable electric razor.	130(p 43) 117(p 19)
02 Provide scissors and re-chargeable electric clippers for hair trimming/cutting.	131(p 50)
03 Provide facilities for conventional (manual and electric toothbrush) oral hygiene.	130(p 43)
04 Provide for vacuum or other convenient method for collection of hair and a retaining bag for nails.	131(p 50) 302(p 4-59, 4-65,4-67)

- 05 Provide individual personal hygiene kits of TBD volume capacity stocked with conventional items of personal preference.
- 1103(p 10-16)117(p 4,5)

CRITICAL ASSUMPTIONSREFER. NO.

- o Provision will be made for the effective and timely conduct of personal grooming activities.
 - o Crewmembers will have personalized items for grooming.
- 132(p C-4-57)
- 117(p 1,2)

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
210 PERSONAL HYGIENE
21005 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.i)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

None

||

CANDIDATE SOLUTIONS

REFER. NO.

None

||

CRITICAL ASSUMPTIONS

REFER. NO.

- o Personal hygiene equipment/fixtures and items will be provided for each HAB module (redundancy/commonality for growth).

133(p 89)

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
211 FOOD/WATER SYSTEMS
21101 MENU

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.e)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

-01 <i>*(A menu of conventional foods shall be provided as follows:</i>	103(p 4-4)
<i>A. frozen C. thermostabilized</i>	100
<i>B. dehydrated D. fresh)*</i>	121
-02 Diet shall provide nutrients in accordance with the "Recommended Dietary Allowances" of referenced document.	103(p 4-7)
-04 <i>*(Provide snacks and beverages.)*</i>	356(p 9)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

o Inflight meal selection based upon available food inventory.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
211 FOOD/WATER SYSTEMS
21103 FOOD PACKAGING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.e)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

-01 Food packaging shall be microgravity compatible.	103(p 4-6)
-02 Food packaging shall protect food from contamination by oxygen, moisture, microbes, and adventitious agents.	357(p 27)
-03 Food packaging shall protect foods from physical damage during shipment, storage, launch, and on-orbit operations.	356
-04 Food packaging shall be compatible with food preparation equipment and trash management equipment.	356
-06 <i>*(Identification and coding of food packaging shall be compatible with automatic inventory systems.)*</i>	356

CANDIDATE SOLUTIONS

REFER. NO.

GEN Package design and materials selection should be accomplished after food types are selected and approved.	356
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CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
211 FOOD/WATER SYSTEMS
21104 FOOD DISPENSING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.e)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

-01 **(Food dispensing methods shall be capable of dispensing single portions.)**

| 103

-02 **(Food dispensing equipment shall display a variety of food item selections.)**

| 103

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

o Real-time menu selection will be provided.

103

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
211 FOOD/WATER SYSTEMS

21105 FOOD PREPARATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.e)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-----|
| -01 <i>*(Frozen and ambient temperature foods shall be heatable by TBD methods to 150 degrees F (65.6 degrees C) in less than 2 hours.)*</i> | 103 |
| -02 There shall be an ability to hold reheated food at 150 degrees F (65.6 degrees C) plus or minus 10 degrees F (5.6 degrees C). | 103 |
| -03 Water at 180 degrees F (82.2 degrees C) hot and 40 degrees F (4.4 degrees C) cold shall be provided for food reconstitution. | 103 |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|---|-----|
| 01 Heat foods using combination of microwave and forced conventional heat. | 170 |
| 02 Hold foods in insulated trays with resistance wire heater to maintain temperature of heated foods and isolated cold foods. | 170 |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
211 FOOD/WATER SYSTEMS
21106 FOOD SERVING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.e)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

-01 <i>*(Food shall be served in containers which enable crew to eat in a conventional manner in the microgravity environment.)*</i>	103
-02 <i>*(Serving utensils shall be designed to pick up bite-size quantities of food and transfer to mouth without spillage.)*</i>	170

CANDIDATE SOLUTIONS

REFER. NO.

01 Provide individual reusable serving trays and utensils for each crewmember.	357(p 40)
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CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
211 FOOD/WATER SYSTEMS
21107 FOOD CLEAN-UP

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.e)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

- | | |
|---|-----|
| -01 <i>*(TBD reusable food serving components shall be designed for detergent washing and sanitizing by chemical and/or heat treatment.)*</i> | 133 |
| -02 <i>*(TBD methods for clean up of food and water spills and cleaning galley surfaces shall be provided.)*</i> | 133 |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|-----|
| 01 Design food serving components for washing and sanitizing using soap/detergent and water followed by chemical or heat sanitizing. | 356 |
| 02 Dry and wet wipes should be provided to clean galley surfaces. | 356 |
| 02 Vacuum cleaner should be provided to pick-up dry or wet food debris or spills. | 356 |
| 02 Food residue placed in biologically active trash containers. | 356 |

CRITICAL ASSUMPTIONS

REFER. NO.

- | | |
|--|-----|
| o Conventional foods will be used which result in predictable amounts of spills, debris, and crumbs. | 356 |
| o Dishwasher will be available. | 133 |

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
211 FOOD/WATER SYSTEMS

21108 POTABLE WATER

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.12.2)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

- | | |
|---|------------|
| -01 Water for drinking and food rehydration shall be 8.6 lbs(3.9 Kg)/man/day. | 133(p 89) |
| -02 <i>*(Hot water temperatures for drinking shall be TBD and heated by TBD methods.)*</i> | 103(p 4-5) |
| -03 Cold and ambient water temperatures shall be 40 degrees plus or minus 5 degrees F (4.4 degrees; 2.8 degrees C) and 70 degrees plus or minus 10 degrees F (21.1 degrees; 5.6 degrees C). | 103(p 4-5) |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

- | | |
|---|-----|
| o Potable water will be derived from onboard water recovery system. | 133 |
|---|-----|

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
211 FOOD/WATER SYSTEMS
21109 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2.e)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

None

CANDIDATE SOLUTIONS

REFER. NO.

NONE

CRITICAL ASSUMPTIONS

REFER. NO.

- o Food and water will be provided for each HAB module (redundancy/commonality for growth). 133
- o Quantity is proportional to number of crewmembers.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

212 HOUSEKEEPING

21201 CONTAMINATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1j)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

(Refer to 20103 for other contamination control requirements)

- | | |
|---|------------|
| -01 Materials used for exposed interior surfaces shall be selected to minimize particulate contamination. | 300(p 80) |
| -02 Exposed surfaces shall be designed to provide for easy periodic routine cleaning. Crevices & narrow openings which can collect liquid or particulate matter and cannot be readily cleaned without special tools shall be avoided. | 103(p 8-1) |
| -03 Any type of grid or uneven surface shall be configured to permit cleaning of all areas. | 103(p 8-1) |
| -04 The galley design shall take into account the need to facilitate clean up of spilled food. One part of the galley system shall be facilities for cleaning and sanitizing food-related utensils. | 103(p 8-2) |
| -06 The sleep area shall be designed to enable the easy changing of sleep restraints and associated bed linens. | 103(p 8-2) |
| -07 Illumination shall be adequate for visual inspection and cleaning of exposed surfaces. | 300(p 81) |
| -09 Subsystems which routinely utilize containers of liquids and particulate matter shall have built-in equipment/methods for control and cleaning of spills. | 300(p 81) |
| -10 Housekeeping tasks shall be minimized by providing close-outs for areas which cannot be accessed by use of crewmember hand cleaning. These close-outs will be designed to prevent accumulation of dirt, debris, and moisture in the area. | 103(p 82) |

- | | |
|--|------------------------|
| -11 Close-out materials shall be compatible with the adjoining materials and the configuration necessary to make closure. Close-outs shall be designed to not stick in place through corrosion, rust, warpage, etc. | 103(p 8-2) |
| -12 Air flow, in addition to its primary function of ventilation and maintaining crew comfort, will be used for odor control and particulate matter control. | 103(p 8-2) |
| -13 Means shall be provided to control odors and/or to remove particulates from a system. All filters shall be easily accessible for cleaning and/or replacement. Means shall be provided to prevent leakage of an entrapped liquid from a filter unit during removal. | 103(p 8-2) |
| -14 Experiments shall provide for safe handling, containment, and disposal of waste by-products. | 300(p 82) |
| -15 Capability shall be provided to control bacterial growth, odors and contamination of the fecal-urine collection system. | 300(p 82) |
| -16 Capability shall be provided for the collection of debris, particulate matter, and water from the atmosphere as well as exposed interior surfaces. | 300(p 82) |
| -20 Standards shall be provided for the safe use of bacteriocides on open surfaces and other potential contaminants inside the Space Station. | 132(C-4-50) |
| -21 Bacterial contamination shall be kept to a minimum. | 131 |
| -22 A means shall be provided to monitor and decrease contaminant levels generated by cleaning materials. | 131(p 89)
130(p 83) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

212 HOUSEKEEPING

21202 CLEANING EQUIPMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1h)

Revised: 10/24/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Cleaning equipment and supplies shall be accessible to and usable by the crews.	132(C-4-50)
-02 All housekeeping subsystems shall be designed to minimize equipment handling and operations.	300(p 82)
-03 <i>*(A wipe subsystem shall be provided to support general housekeeping as well as personal hygiene.)*</i>	103(p 8-4)
-04 A means shall be provided for dislodging and collecting dirt and debris from equipment and surfaces.	300(p 83)
-05 <i>*(Screens, filters, and/or other methods of capturing liquids and solid particulates shall be provided at strategic locations near workstations and equipment which generate these materials. These capture elements shall be easily accessed for replacement or cleaning without risk of dispersion of trapped materials.</i>	300(p 82) 103(p 8-2)
-06 <i>*(A vacuum cleaner with both positive and negative air pressure for localized or specific cleaning shall be provided. The vacuum cleaner shall be nonpropulsive and provide accessories for cleaning various filters, crevices and narrow openings.)*</i>	300(p 83) 103(p 8-4)
-07 Provide for one-handed operation of cleaning equipment.	300
-08 Biocides shall be compatible with ECLSS and not be a health hazard to the crew.	132(C-4, 2.2.10.1h)
-09 Biocides shall not stain or discolor the surface being cleaned or the crewmembers hands.	131(p 49) 172(p 16)

CANDIDATE SOLUTIONS

REFER. NO.

- | | | |
|----|--|------------------------|
| 03 | A representative subsystem might consist of the following four basic types: | |
| | 1. Utility dry wipes- used as toilet tissue and for compartment and equipment cleaning. | |
| | 2. Wet wipes (saturated with germicide)- used for personal hygiene and eating utensil cleanup. | |
| | 3. Biocide wipes (non-woven cotton fiber pads containing a germicide solution)- used for bacterial control of the fecal/urine collection system, the galley/dining area, the personal hygiene station, and various equipment surfaces. | |
| | 4. Tissues- provided for personal hygiene and small clean-up tasks. | |
| 05 | Use replaceable screens to collect loose items, spills, etc. | 131(p 88)
128(p 62) |
| 06 | The vacuum cleaner should provide stronger suction than those used on the Skylab and current Shuttle Orbiter missions. | 172(p 16)
300(p 44) |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

212 HOUSEKEEPING

21203 TASKS

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.4);
C-4(2.2.10.1h)

Revised: 9/25/85

REQUIREMENTSREFER. NO.

- | | |
|---|--------------|
| -01 Housekeeping tasks shall be defined and documented. A checklist shall identify each task, required equipment, including its location, and detailed crew procedures. The task shall be categorized as to type of task and estimated crew times for completion. | 303(p 6-104) |
| -03 A method shall be provided to control and record the performance of housekeeping tasks and the manpower allocated to them. | 303(p 6-104) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

DESIGN/OPERATIONS REQUIREMENTS

212 HOUSEKEEPING

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.4);
C-4(2.2.10.1h)
Revised: 9/25/85

REFER. NO.

103 (p 8-5)

REFER. NO. _____

REFER. NO.

- * An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
212 HOUSEKEEPING
21205 CLOTHES WASHER/DRYER

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2k)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

- 01 **(A laundry facility shall be provided (including washer/dryer).)** | 133(p 99,
| 479)
| 169(p 167)
- 03 **(The laundry facility shall provide for cleaning of intravehicular apparel, extra-vehicular inner cooling garments, crew clothing, sleep restraints, towels and wash-cloths).** | 132(C-4-58)
- 04 The laundry facility shall incorporate features to prevent contamination of the cabin atmosphere. | 132(C-4-58)
- 05 **(Detergent selection shall be compatible with ECLSS water reclamation).** | 132(C-4-58)

CANDIDATE SOLUTIONS

REFER. NO.

- 01 Wash- one or two loads per day | 169(p 176)
Power- 340 watts AC intermittent, 15 watts
DC intermittent
Volume- 6 cubic ft
Water quantity- 110 lbs/wash- room temperature
Water removal- pump to water processing and
management system
Weight- 90 pounds
- 01 The washer/dryer may operate as follows: | 169(p 172)
The machine for clothes washing will operate in the following manner. The clothes will be placed in a continuously rotating basket. A water jet will spray a 0.1 concentration of detergent over the clothing for cleansing, followed by a rinsing spray which contains a bactericide. High RMP's will extract the liquid after each cycle and the clothes will be dried by ambient or warm air.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

212 HOUSEKEEPING

21206 DISHWASHER

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2e)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

- | | |
|--|--------------------------|
| -01 *(A dishwasher/dryer, per design requirements, shall be provided for cleaning reusable dishes and utensils in D-g.)* | 133(p 89)
132(C-4-55) |
| -04 The dishwasher shall be located in the galley. | 133(p 89)
132(C-4-55) |
| -05 The dishwashing facility shall incorporate features to prevent contamination of the cabin atmosphere. | 132(C-4-58) |
| -06 Detergent selection shall be compatible with ECLSS water reclamation processes. | 132(C-4-58) |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|------------|
| 01 Wash- one or two loads per day
Power- 240 watts AC intermittent, 15 watts DC intermittent
Volume- 8 cubic ft
Water Quantity- 16 lbs/wash
Water Removal- pump to water processing system
Weight- 30 pounds | 169(p 176) |
| 01 An automatic dishwasher may function as follows: Items are placed in trays and enclosed in a cabinet where rotating water jets are directed on the items. A detergent is dispensed during the wash cycle to clean the items. Reused water is then directed on the items to remove the detergent. After the reuse cycle, warm air is blown over the items to dry them. The wastewater is pumped to the water processing and management system. | 169(p 172) |

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

213 WASTE/TRASH MANAGEMENT

21301 TRASH GENERATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1h)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

Note: For the purposes of this document, Waste is defined as bodily waste and Trash is defined as all other material to be disposed of.

(For Waste Management refer to 210.)

(For Trash-Waste Stowage/Storage refer to 10903.)

- | | |
|--|------------------|
| -01 *(Adequate provisions shall be made for trash.)* | 300(p 25)
303 |
| -02 *(Provisions shall be made for amounts, types & locations of potentially dangerous waste/trash items.)* | 300
303 |
| -04 *(Locations of greatest trash generation shall be identified.)* | 103(p 8-3) |
| -05 *(Trash items which required special collection, processing or storage techniques shall be identified.)* | 300(p 25) |
| -06 Adequate provisions shall be made for waste management. (Refer to 210) | 155 |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|---|----------------------|
| 01 Empirical studies should be performed using Space Station simulators to estimate types and amounts of trash expected on Space Station. | 300(p 30)
300 |
| 01 If empirical studies are not performed, trash generation should be based on theoretical studies, past simulator tests, and trash generation on previous manned missions. | 300(p 30)
305,306 |

CRITICAL ASSUMPTIONSREFER. NO.

- o Trash items generated on previous manned
space flights will be representative of those
expected on Space Station. 300(p 34)
304
306
- * *An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.*

2 CREW SUPPORT

213 WASTE/TRASH MANAGEMENT

21302 TRASH COLLECTION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1h)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

(Also Refer to 10903 Trash-Waste Stowage/Storage

- | | |
|--|--|
| -01 Provide galley trash collection. | 133(p 60,89) |
| -02 <i>*(Galley trash collection shall include methods to manage wet and dry trash.)*</i> | 132(C-4-50, C-4-55) |
| -03 <i>*(Trash containers shall be provided in private crew quarters and the wardroom.)*</i> | 128(p 36) |
| -04 <i>*(A minimum of 2 wet and 2 dry trash stowage locations in each of the habitat modules and laboratory modules shall be provided.)*</i> | 133(p 60) |
| -05 <i>*(Trash receptacles and liners shall be provided in locations convenient to workstations and subsystems generating trash and debris. The type of liners within each receptacle shall be characteristic of the state and attributes of the trash generated in that area.)*</i> | 300(p 84)
132(C-4-50)
103(p 8-3)
102(p 6) |
| -06 Trash collection devices shall not interfere with movement. | 103(p 8-3) |
| -07 <i>*(Trash receptacles and liners shall be designed with an opening for introducing trash and with a system for physical retention of trash.)*</i> | 300(p 84)
103(p 8-3)
100(p 30) |
| -08 Trash receptacles shall be clearly labeled to indicate the types of trash to be deposited. (Also see 21303-03) | 300(p 84) |
| -09 Receptacle liners shall be identified by labeling or color coding to insure their content can be determined when separated from their receptacles. (Also see 10303) | 300(p 84) |
| -13 Trash collectors shall be designed to preclude contamination during introduction of trash. | 155 |

CANDIDATE SOLUTIONSREFER. NO.

07	Provide a place to stow trash "external" to the habitable volume of the spacecraft.	131(p 89)
07	Provide two trash compactors (one large and one small) plus a backup unit.	131(p 89)
07	Design food containers to be of minimal volume at time of discard.	131(p 89)
07	Provide temporary trash collection sites for daily work collection.	131(p 89)
01	Provide bags for food leftovers and packaging.	131(p 87)
01	Provide sufficient trash disposal for each crewmember.	131(p 87)

CRITICAL ASSUMPTIONSREFER. NO.

o	Wet biologically active trash will be collected in separate containers than dry inactive trash.	102(p 6) 307(p 83, 84)171(p 2)
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* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
213 WASTE/TRASH MANAGEMENT
21303 TRASH SORTING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1h)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

-01 *(Trash shall be separated into biologically active and inactive materials.)*	128(p 62) 131(p 88)
-03 Trash receptacles shall be labeled and/or color coded to indicate the types of contained trash. (Also see 10303)	300(p 45) 303(p 96, 97)

CANDIDATE SOLUTIONS

REFER. NO.

None

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CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

- 2 CREW SUPPORT
- 213 WASTE/TRASH MANAGEMENT
- 21304 MICROBIAL STABILIZATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1h)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

(Also see 20103 Contamination/Odor Control)

- 01 **(The habitat areas shall be arranged and designed to accommodate the stabilization of trash. The equipment necessary for trash stabilization shall be conveniently located.)** | 126(p 32)
| 132(C-4-50)
- 02 **(Trash shall be treated to prevent it from producing gas or odors.)** | 132(C-4-50)
- 03 **(Biologically active trash shall be treated or processed to render it safe so that any micro-organism growth or gases produced will not impair crew health.)** | 103(p 8-3)
- 04 All trash items with the potential for off-gassing shall be identified. | 132(C-4-50)
- 05 All biologically active trash shall be stabilized prior to long term storage. | 132(C-4-50)
| 103(8-3)

CANDIDATE SOLUTIONS

REFER. NO.

- 01 Vacuum desiccation should be used as the primary means of microbial stabilization with liquid germicide sterilization as a contingency. | 300(p 54)
| 303(p 5-3
| Thru 5-10)
- 01 Combine the microbial stabilization process with the trash compactor. | 300(p 155)
| 309(p 25
| Thru 27)

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
213 WASTE/TRASH MANAGEMENT
21305 WASTE/TRASH TRANSFER

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1h)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

- 02 Handholds, restraints, and aids for locomotion shall be provided for transfer of collected waste/trash items. During transport of harmful waste/trash the shielding and routes shall be such that contamination hazards to personnel and provisions are minimal. When possible, these materials shall be deactivated before transfer. (Also refer to 215, Restraints and 216 Mobility Aides) | 300(p 85)
- 03 Waste/trash containers shall be designed to preclude rupture. | 155

CANDIDATE SOLUTIONS

REFER. NO.

- GEN Waste/trash shall be transferred from module to module by utilizing a combination of direct manual handling and automated systems. | 300(p 61-62)

CRITICAL ASSUMPTIONS

REFER. NO.

- o The trash transfer system will combine direct manual handling with provisions for automated trash handling.
- * An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
213 WASTE/TRASH MANAGEMENT
21306 VOLUME REDUCTION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1h)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

-01 *(Trash compactors shall be supplied as part of the standard equipment on the Space Station. They shall be used with all possible trash to reduce the volume necessary for trash storage.)*	103(p 8-3) 132(C-4-50) 131(p 49) 102(p 6)
-02 The trash compactor shall be designed for odor control.	169(p 166)
-03 Galley trash compaction for wet and dry trash shall be provided.	133(p 89)
-05 Trash containers shall be designed to preclude rupture during compaction.	155
-06 Trash generating material shall be designed to retain minimum volume when discarded and compacted.	128(p 62) 102(p 6)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
213 WASTE/TRASH MANAGEMENT
21307 WASTE/TRASH DISPOSAL

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1h)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

(Also refer to 10903 Trash-Waste Stowage/Storage)

-01 A means shall be provided to dispose of biologically active trash.	131(p 88)
-02 <i>*(Waste/trash shall be temporarily stored in the logistics module.)*</i>	300(p 74)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
213 WASTE/TRASH MANAGEMENT
21308 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1h)

Revised: 9/25/85

REQUIREMENTS

REFER. NO.

-01 **(Increased trash management provisions shall be made for station growth.)** |103(p 8-3)
|132(C-4-50)
|102

CANDIDATE SOLUTIONS

REFER. NO.

- 01 Provide an additional trash compactor with each additional habitat module.
- 01 Provide additional trash receptacles with additional HAB and LAB modules.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
214 SUPPLY SUPPORT
21401 RESUPPLY REQUIREMENTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.14)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

-02 Provide preventive maintenance materials and supplies.	1131(Vol 1 p 124)
-03 <i>*(Provide consumables and spares to be compatible with initial design and resupply capability, and in accordance with maintenance analyses/reliability estimates/risk considerations/onboard limitations.)*</i>	1131(Vol 1, p 131)
-06 Provide an easy to use, practical inventory control system.	1131(p 67)
-07 The capability for rapid assessment of additions, deletions and changes to equipment stowage should be provided.	1172(p 25) 1100(p 50)

CANDIDATE SOLUTIONS

REFER. NO.

03 Perform detailed maintenance analysis of all operational flight hardware to identify necessary ORU's. Perform mission simulations to achieve confidence that types & quantities of defined ORU's will satisfy mission integrity requirements.	
02 Perform Logistic Support Analyses (LSA) to depth necessary to define materials and quantities adequate for mission support between resupply events.	
03 Perform mission analyses and simulations to extent necessary for confidence in identification of resupply needs.	1124(p 3-13)

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

214 SUPPLY SUPPORT

21402 INVENTORY MANAGEMENT AND CONTROL

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.14)

Revised: 10/24/85REQUIREMENTSREFER. NO.

- | | |
|--|---|
| -01 <i>*(Provide an efficient and easy-to-use inventory management system (IMS) which will provide status of consumables and current location reference of onboard resources without crew input.)*</i> | 124(p 10-3)
 128(p 54)
 131(Vol 1,
 p 247) |
| -02 <i>*(Output of inventory data shall be in exact format as used by crew and compatible with realtime uplink for onboard presentation. Onboard and ground inventory data formats shall be identical.)*</i> | 128(p 54) |
| -03 Information shall be indexed with as many cross categories as required. | 128(p 54) |
| -07 "User-friendly" software shall be provided for inventory purposes, among other uses, and should be prepared and provided in a manner that can be easily changed to permit tailoring for unique cargo or mission characteristics. | 131(Vol. 1,
 p 411) |
| -08 Inventory records shall be structured such that the performance history of each listed item can be easily retrieved. | 131(Vol. 1,
 p 157) |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|---|------------------------|
| 01 Review existing IMS and identify/analyze good and bad points. Structure Space Station IMS as amalgamation of best attributes so derived and to accommodate information both resident onboard and available through uplink from ground. | 172 |
| 01 Spare parts nomenclature/serial and part numbers should be easy to read, located where they can be read both when stowed and when in use, and should be located where they will not be damaged during storage or use. | 131(Vol. 1,
 p 131) |

- | | | |
|----|---|--------------------|
| 01 | Provide distinctive color/pattern coding and labeling of similar items, i.e., units whose differences are largely functional. | 131(Vol. 1, p 247) |
| 08 | Criticality of Space Station equipment in the operational environment dictates that all flight units should have an easily traceable performance history. (It may not be necessary to input such data onboard.) | 172 |

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

214 SUPPLY SUPPORT

21404 TRANSPORTATION AND HANDLING

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(3.4)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-----------------------|
| -02 Where possible a storage container shall be used to transfer its contents from one location to another. | 131(Vol 1,
 p 247) |
| -04 <i>*(Mass configuration, and size of manually-handled items shall be compatible with hatch size and turning radii as well as handling capability of crewmembers.)*</i> | 131(Vol 1,
 p 375) |
| -06 Resupply items are to be easily removable from the resupply vehicle in 0-g. | 131(Vol 1,
 p 375) |
| -07 Logistics supply items requiring removal one at a time in a programmed sequence shall be oriented to allow for removal in the required sequence. | 310(3-101) |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|--------------------------|
| GEN Provide see-through containers with simple, easy-to-use, closures for transporting papers and small items. | 131(Vol 1,
 p 215) |
| GEN Provide containers of resupply items with simple-to-release tie-down devices. | 131(Vol 1,
 p 375)172 |
| GEN Provide bulk packing of supplies such that packages can be exchanged with expended ones. | 131(Vol 1,
 p 375) |
| 02 Provide detachable containers with handles for contents that are to be transferred from one location to another as a group. | 131(Vol 1,
 p 215) |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
214 SUPPLY SUPPORT

21407 PRESERVATION, PACKING & PACKAGING

CROSS REFERENCE TO RFP PARAGRAPH NO: C-3(3.4)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- | | |
|---|----------------------|
| -01 All components subject to removal/replacement, or which otherwise require ready identification by the crew, shall be clearly labeled. | 131(Vol 1,
p 92) |
| -02 Spare parts shall be easy to remove from package/storage and packages shall be usable for stowage of used parts without extensive manipulation of packing material. | 131(Vol 1,
p 131) |
| -03 Efficient and convenient means of opening packages, and for closing/sealing packages, shall be provided. | 131(Vol 1,
p 499) |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|---|----------------------|
| 01 Use labels with same terminology as documentation, where practical. | |
| 02 Provide molded reusable packaging of spare parts. Use as few pieces of packaging material as possible. | 131(Vol 1,
p 131) |
| 03 Provide crewmembers with pocket knives. | 131(Vol 1 |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
215 RESTRAINT SYSTEMS
21501 FOOT RESTRAINTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1g)

Revised: 10/24/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Restraints shall be designed for 0-g posture compatability. Restraint design shall minimize or eliminate muscular tension and not require conscious effort to remain constrained.	105(p 9) 113
-02 <i>*(Unique foot restraint designs shall be minimized and standardized design shall be maximized.)*</i>	105(p 15) 113
-03 Comfort of the restraint system shall allow for 4-hour uninterrupted use.	132(C-4-49)
-04 Foot restraints shall not interfere with movements when not in use.	132(C-4-49)
-05 Foot restraints shall facilitate ingress and egress without the use of hands at the restraint. Handholds or adaptable structure shall be available at all positions to aid ingress and egress.	132
-07 Foot restraints shall be easily repairable and/or replaceable.	113
-08 Any portion of the restraint worn on the foot shall be as lightweight as possible.	113
-09 The foot restraint shall be positive & firmly hold the user in the desired position.	113
-10 The foot restraint shall be capable of being engaged & disengaged easily & quickly.	113
-11 The foot restraint shall permit the user to change his position during use in order to allow full advantage to be taken of the 0-g envelope of operations.	113
-12 A portable form of the foot restraint shall be available for installation at various	113

temporary work sites within the Space Station.

- | | |
|--|-------------|
| -13 Foot restraints shall be adjustable to permit the specified crewmember range to perform manipulative tasks at chest level. | 138 |
| -14 If foot restraints are used to stabilize the crew while bathing, they shall be compatible with bare feet. | 132(C-4-58) |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
215 RESTRAINT SYSTEMS
21502 BODY RESTRAINTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1g)

Revised: 10/24/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Exposed equipment shall be designed to withstand the forces & impacts imposed by crewmembers using it as a body restraint.	111(p 34,3)
-02 The restraint/work surface relationship shall be designed to accommodate the natural 0-g body position to minimize muscle tension & fatigue.	111(p 35,6)
-03 Three point restraints shall be provided for tasks requiring precision stability.	111(p 35,8)
-04 Specific restraint aids shall be provided for tasks which must be performed in the crouched position.	132(C-4-50), 343
-05 <i>*(A positive versatile body restraint system shall be provided for crewmember use throughout the space station. The system shall be fully adjustable, permit a full range of operations about the attachment point(s), and permit free use of both hands & upper torso for manipulative tasks.)*</i>	132(C-4-50)
-06 The body restraint system shall be capable of on-orbit cleaning and repair.	132(C-4-50)
-07 All restraints shall accommodate the full range of anthropometric requirements.	

<u>CANDIDATE SOLUTIONS</u>	<u>REFER. NO.</u>
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None

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
215 RESTRAINT SYSTEMS
21503 EQUIPMENT RESTRAINTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1g)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- | | |
|---|----------------------------|
| -01 Equipment restraints shall not conceal hardware identification marks on stowed equipment. | 138(p 33) |
| -02 Book/checklist use aids and restraints shall be designed into all workstations; locations shall consider lighting requirements, facing angles print size/eye distance, and relaxed 0-g body position. | 138(p 35) |
| -03 <i>*(A standard cable management technique shall be provided to restrain extension cables throughout the station.)*</i> | 118(p 6) |
| -05 Drawers & cabinets shall be equipped with suitable restraints to allow access, removal and restowage of equipment. | 132(C-4-48) |
| -06 Stowage areas shall be compartmented to aid in the control of equipment during stowage and removal. | 132(C-4-48)
124(App. C) |
| -07 <i>*(The capability for temporary restraint of equipment shall be available near stowage areas & throughout the Space Station.)*</i> | 132(C-4-48) |
| -10 All workstations associated with windows for operators & scientific research shall have provisions for the following items where dictated by the requirements analysis: mounted voice tape recorder, event timer, means to mount cameras, means to secure handheld cameras, small light, method to secure paper & checklists, writing station, body restraints, display & keyboard, maps, moving map display with an optical device to view the flight path, orbital maps to identify future flight paths, method of measuring angles & the horizon, control of adjacent lighting, easily deployed hood or curtain to block interior light. | 132(C-4-48;
C-4-54) |

CANDIDATE SOLUTIONSREFER. NO.

None

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CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
215 RESTRAINT SYSTEMS
21504 SLEEP RESTRAINTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1g)

Revised: 9/30/85

REQUIREMENTS

REFER. NO.

-02 Standardized sleep restraint design shall be provided.	108(p 18) 107(p 26)
-03 Sleep restraints shall include provisions to prevent head nod during sleep.	138
-04 Sleep restraint design shall eliminate excessive or unevenly distributed trapped air.	108(p 18)
-05 Sleep restraints shall be designed to facilitate ingress/egress.	108(p 18)
-06 One sleep restraint shall be provided for each crewmember.	155

CANDIDATE SOLUTIONS

REFER. NO.

GEN Sleep restraints shall be easily stowable, transportable, and cleanable on-orbit.	
02 A sleep restraint should incorporate the following: a) Adjustable, flexible restraint straps, b) Arm slits, c) Adjustable removable pillows, and d) Adjustable thermal protection.	

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

215 RESTRAINT SYSTEMS

21505 PORTABLE RESTRAINTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1g)

Revised: 9/26/85REQUIREMENTSREFER. NO.

- | | |
|---|--|
| -01 <i>*(A portable adjustable crew restraint system shall be provided that will facilitate crew-members positioning & stabilization at all potential work or off-duty sites.)*</i> | 132(C-4-49)
 124(app C,
 B-1-34) |
| -02 Space Station structure shall be designed to accept portable restraints. | 132(C-4-49) |
| -03 Portable handholds shall be designed to provide an indication or cue to inform the user that the handhold is positively locked in position. | 160, 155,
 132(C-4,
 2.2.10.1g) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
215 RESTRAINT SYSTEMS

21506 HANDHOLDS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1g)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

-01 Items that require moving shall have built-in handles and/or structural or mechanical parts suitable for gripping in compliance with anthropometric criteria.	132(C-4-48)
-02 Handholds/hand rails shall be strategically located.	132(C-4-50)
-03 Handholds shall be clearly visible under all conditions of illumination.	155, 160, 132(C-4, 2.2.10.1c)

CANDIDATE SOLUTIONS

REFER. NO.

02 E.g. at workstations, hatches, etc.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
216 MOBILITY AIDS

21601 INSTALLED EQUIPMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1g)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- | | |
|---|---------------------------------------|
| -01 Installed items that require moving shall have structural or mechanical parts suitable for gripping in compliance with anthropometric criteria. | 132(C-4-50),
 2.2.10.1.g.1
 146 |
| -02 Structural components that may not double as mobility aids shall be identified. | 311(p 79,
 pp 2.2) |
| -04 <i>*(A crew translation aid shall be provided for efficient handling of equipment & small parts during translation.)*</i> | 132,138
 |

CANDIDATE SOLUTIONS

REFER. NO.

01 Built-in or portable handles could be used.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

DESIGN/OPERATIONS REQUIREMENTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1g)

Revised: 9/26/85

REFER. NO.

CANDIDATE SOLUTIONS

REFER. NO.

01 Built-in or portable handles could be used.

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
217 COMMUNICATIONS
21701 SYSTEMS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.6)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- | | |
|--|------------|
| -01 Provisions shall be made for voice communication between all points in the Space Station, and between EVA & IVA crewmembers. | 131(p 427) |
| -02 Auditory feedback within the communication system shall be avoided. | 131(p 427) |
| -04 As a design goal, where headsets are required, they shall be wireless, comfortable, and convenient. | 131(p 427) |
| -05 Crewmembers shall receive information without the need for monitoring the reception process. | 131(p 391) |
| -06 All communication systems shall indicate operating status, receive or transmit. | 131(p 391) |
| -07 Communication system shall not be interlocking so that one switch can interfere with the whole system. | 131(p 391) |
| -08 Sufficient signal intensity and background contrast shall be provided to ensure clear communication. | 131(p 391) |
| -09 Provide an automatic video means of presenting the following, including but not limited to: system diagrams, maintenance (type, quantity, storage location), procedures, diagrams/schematics, uplink of graphic data) training programs, skill maintenance (simulation of dynamic procedures), educational programs, news, sports, and first run movies. | 131(p 423) |
| -10 Provide a means of recording and editing visual information. | 131(p 423) |
| -11 Provide hard copy capability. | 131(p 423) |
| -12 Communication equipment installations shall be modular and reconfigurable. | 155 |

- | | |
|--|------------|
| -13 Noise level within the Space Station shall be controlled to enable direct voice communication at normal speech ranges. | 131(p 427) |
|--|------------|

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|---|------------|
| 01 Provide portable two-way radio in addition to fixed base intercom. | 131(p 427) |
| 02 Provide a means of isolating speaker output from microphones. | 131(p 427) |
| 06 Provide illuminated annunciation of transmit/receive status of communication system channels. | |
| 10 Provide a video tape recorder capable of recording at rapid rates and compatible with on-board playback equipment. Provide video tape editing equipment. | 131(p 423) |

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
217 COMMUNICATIONS

21702 LOCATIONS

CROSS REFERENCE TO RFP PARAGRAPH No.: C-4(2.2.6)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

-01 Space Station personnel shall be able to
communicate with each other from any location
within the Space Station complex. | 131(p 392)
|

CANDIDATE SOLUTIONS

REFER. NO.

01 Provide a two-way intercom system | 131(p 392)
|

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.*

2 CREW SUPPORT

217 COMMUNICATIONS

21703 FUNCTIONAL TYPES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.6)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-------------|
| -01 Commercial color TV and CCTV shall be available. | 132(C-4-34) |
| -02 The C&T design shall provide for crewmembers to communicate privately with the ground. This private communications link shall include both audio and video data. | 132(C-4-39) |
| -03 Provide secure communication between Space Station personnel and ground control. | 131(p 431) |
| -04 Provide audio and visual communications for crew to have regular contact with family and friends. | 131(p 431) |
| -05 Provide a means of receiving visual information at remote work/repair sites. | 131(p 415) |
| -06 Provide a microphone with good voice pickup at 12 inches away. | 131(p 415) |
| -07 Space Station personnel shall have access to an area that enables private viewing for personal communications. | 131(p 415) |
| -08 Space Station personnel shall be able to view television broadcasts as a group. | 131(p 415) |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|---|------------|
| GEN Provide portable "CRT". | 131(p 415) |
| GEN Provide helmet mounted microphone in accordance with requirement. | 131(p 415) |
| GEN Provide video conferencing capabilities in crew quarters. | |

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
217 COMMUNICATIONS
21705 RECORDKEEPING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.6)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

-01 The C&T design shall provide the capability to record voice and/or audio.	132(C-4-34)
-02 The C&T system shall provide storage and retrieval of TV and CCTV.	132(C-4-34)
-03 Space Station personnel shall be able to record ground to space information transmission for later use.	131(p 431)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
217 COMMUNICATIONS
21706 NONNORMAL COMMUNICATIONS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.6)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

-01 Provisions shall be made for a contingency command and telemetry link to the ground from the Space Station and Space Platforms.	132(C-4-35)
-02 Provisions shall be made for visual communications between IVA and EVA crewmembers.	132(C-4-34)

CANDIDATE SOLUTIONS

REFER. NO.

02 Provide virtual windows from IVA workstation to EVA work areas.	

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
218 QUALITY ASSURANCE
21801 PROCEDURES VERIFICATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.12)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

-01 Quality Assurance	132(C-4-22)
Quality assurance program requirements for the	
SSP are defined in SSP reference document,	
"Product Assurance Requirements for the Space	
Station Program", (J8400001).	
-02 On-Orbit Procedures Verification	313
The crew shall be the primary method for veri-	
fication of the correct completion of on-orbit	
manual procedures, & shall provide a secondary	
method for verifying procedures completed	
autonomously.	

CANDIDATE SOLUTIONS

REFER. NO.

None

|

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
218 QUALITY ASSURANCE
21802 CONDITION VERIFICATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.12)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-----|
| -01 The crew shall be assigned the responsibility to assure that specific critical characteristics of systems, subsystems, and components are maintained or obtained. This may be in conjunction with Space Station system assembly, maintenance, repair, and operations; or it may be required for user support operations. | 313 |
| -02 Verification of controls on processes such as welding, soldering, or bonding shall be the responsibility of the crewmember performing the process. | 313 |
| -03 A routine approach to the maintenance of the quality of software that can be modified by crew action shall be developed & implemented. | 313 |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT
218 QUALITY ASSURANCE
21803 CONTROL

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.12)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- | | |
|--|------------------------|
| -02 A means shall be provided to visually display the status of the integrity of critical equipment enclosures, fluid line connections, electrical/electronic connections, and mechanical fasteners. | 313 |
| -03 Flammable materials exposed to the ambient atmosphere of the Space Station habitable volumes shall be separated to prevent flame propagation paths. Similarly, separation of flammable materials from potential ignition sources is required to the maximum extent possible. | 132(C-4,
2.1.11.3c) |
| -04 The means to readily and accurately verify the control of loose parts shall be provided in the design and in operational documentation. | 313 |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|---|-----|
| GEN Provide attachable tags or decals, bend tabs, etc., to mark parts to indicate that parts are discrepant. | 313 |
| GEN Provide equipment and procedures to verify fluid connections. | 313 |
| GEN Provide the capability to initiate laminar flow control of vapor migration at hatchways where free personnel transfer capability and control of atmosphere migration are required simultaneously. | 313 |
| 02 Provide equipment enclosure integrity seals and fitting torque stripes, or similar devices used in ground facilities, modified for O-g/closed environment applications. | 313 |
| 02 Develop a method or methods of providing a visual display of the integrity of equipment | 313 |

	enclosures similar to equipment integrity seals used in ground test or operational facilities.	
02	Develop a method or methods of providing a visual display of the integrity of fluid and electrical connectors, and mechanical fasteners, similar to torque stripes used in ground facilities.	313
04	Provide O-g handling caddies/storage volumes such that the absence of loose parts is readily detectable by visual inspection.	313
04	Avoid requirement for potentially loose parts that are too small to be handled or seen readily and easily.	313
04	Consider finishes for parts or tools that are readily visible against normal spacecraft interior backgrounds.	313
04	Provide detailed tool/piece part accountability checklists in operational procedures.	313

CRITICAL ASSUMPTIONSREFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

218 QUALITY ASSURANCE

21804 EQUIPMENT CALIBRATION/CERTIFICATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.12)

Revised: 9/26/85REQUIREMENTSREFER. NO.

- | | |
|--|---------------|
| -01 The capability shall be provided for onboard calibration of equipment requiring high accuracy. | 124(10.1.2.3) |
| -02 An onboard metrology system shall be established, documented, and maintained to ensure that measurement standards and equipment used to calibrate onboard operational or user devices are adequate to achieve the accuracy required by controlling specifications. | 312(4.8) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT

218 QUALITY ASSURANCE

21805 ANOMALY INVESTIGATION, ANALYSIS & EVALUATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.12)

Revised: 9/26/85REQUIREMENTSREFER. NO.

-02 *(Software problem reporting shall be included
in the Space Station system problem reporting
and corrective action system.)*

312
(4.13.10)CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.

2 CREW SUPPORT
218 QUALITY ASSURANCE
21806 REPORTING AND RECORDING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.12)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- 02 **(A quality assurance reporting and recording system will be developed which provides the capability to maintain cognizance of the quality characteristics of specific Space Station systems or hardware and software elements, and to verify the general level of quality of the total Space Station system. The requirements for submittal of quality reports and records by the flight crew during orbital operations is TBD.)** | 313
- 03 **(Quality surveys will be performed at periodic intervals to provide an overall status report on Space Station operations and habitability conditions. A checklist will be developed to record the conditions observed including general housekeeping, displays and controls, decals and cue cards, stowage configuration maintenance subsystem status, workstations, general wear etc. Survey frequency is TBD.)** | 313

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

2 CREW SUPPORT

218 QUALITY ASSURANCE

21807 DETECTION, ISOLATION, AND IDENTIFICATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.12)

Revised: 9/26/85REQUIREMENTSREFER. NO.

-01 *(A means shall be provided to detect, isolate
and identify the exact location of a point
of leakage in the pressure membrane of
habitable volumes.)*

313
|
|
|CANDIDATE SOLUTIONSREFER. NO.

None

|

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.

2 CREW SUPPORT

219 CLOTHING

21901 IV CLOTHING (UNDERWEAR AND OUTERWEAR)

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2j)

Revised: 10/24/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Clothing shall be provided for exclusive use of each crewmember.	103(p 6-1),104(p 51)
-03 Clothing shall be capable of being donned/doffed by a crewmember, unassisted in O-g.	103(p 6-1)126(p 31)
-04 <i>*(Materials shall be compatible with cleaning/washing methods.)*</i>	103(p 6-1)104(p 51)
-05 <i>*(Suitable types of closure/adjustments accommodating body measurement changes shall be provided in clothing design.)*</i>	103(p 6-1)104(p 51)
-06 Clothing shall be designed to allow efficient use of commodes/urinals and allow unrestricted mobility.	103(p 6-1)104(p 51)
-07 Clothing shall provide thermal comfort.	104(p 51)110(p 20-23)
-08 All crew clothing will be government furnished equipment.	132(C-4-58)
-11 Clothing for each crewmember shall be identified.	359
-12 Common clothing styles shall be utilized for male and female crewmembers to greatest extent possible.	104(p 51)103(p 6-1)
-15 Clothing design shall incorporate sufficient stowage features for needed small items.	110(p 24-29)104(p 51)
-16 <i>*(Clothing for hazardous operations shall be provided.)*</i>	126(p 31)
-18 Footwear shall be compatible with the restraint system.	104(p 51)
-19 Gloves shall be provided in different weights	103(p 6-2)

and materials to accommodate efficient use requirements.

CANDIDATE SOLUTIONS

REFER. NO.

GEN Use absorbent, air permeable fabric such as cotton.	
GEN Provide shorts/panties; t-shirt/bra; socks as designated by personal preference.	
GEN Provide thermal underwear if requested.	
GEN Clothing quantities per crewmember should be a function of garment maintenance.	128
GEN Provide "multi-use" garments.	104p 6-2)
03 Use fasteners with ease of operation such as slide fasteners, hook/pile, snaps.	
03 Use slide fasteners for major garment entries, such as jacket and trouser openings.	
07 Provide thermal adjustability with multiple garment system.	103(CH.6) 110(p 20) 104
10 Supply some or all clothing from off-the shelf sources or allow personal clothing.	103(CH 6) 104(p 51)
11 Use colored permanent tag system for personal clothing identification during mission.	
13 Provide a choice of colors and styles for visual variety and personal preference.	104(p 51) 110(p 52)
15 Incorporate pockets sized for books, tools, pencils, etc.	
16 Provide disposable protective overgarments for hazardous operations.	103(p 6-3)
18 Modify footwear to incorporate a foot restraint interface.	103(p 6-2)

CRITICAL ASSUMPTIONS

REFER. NO.

- o Clothing will be sized to accommodate 5% Oriental female - 95% American male populations adjusted for 30 year growth trends from the baseline estimate year 1985 extrapolated to the year 2000. 132(C-4-47)
- o Clothing will provide: function; comfort; bodily protection; allowance for physiological changes.

- o Supply clothing in sufficient quantities for a 90-day mission. These quantities being dependent upon use of TBD laundry system and/or TBD resupply mission system, and/or 90-day inventory system.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

2 CREW SUPPORT
219 CLOTHING
21903 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2j)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

None

|||

CANDIDATE SOLUTIONS

REFER. NO.

None

|||

CRITICAL ASSUMPTIONS

REFER. NO.

- o Provisions of clothing will increase proportionally as size of mission crew grows.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

REPORT FORMAT 3.1

DESIGN/OPERATIONS REQUIREMENTS

2 CREW SUPPORT

220 VIBRATION

22001 VIBRATION CONTROL

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(4b)

Revised: 9/30/85REQUIREMENTSREFER. NO.

-01 *(Station and equipment vibration limits shall be defined and imposed on all equipment installations.)*

130(p 27)
159(p 173-
178)

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

301 CREW TRAINING

30101 TRAINING METHODS

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.5)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

-06 Extensive preflight training capability shall be limited to critical system functions with emphasis on part-task training. Infrequent and low criticality task training capability shall be conducted on a minimal basis on the ground, supplemented by on-orbit refresher lessons, and on-the-job training using onboard training capabilities.

132(C-3-11,
2.5c)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

o Preflight ground training will include part-task trainers and full team simulation.

o Payload unique training shall be provided by the customer.

132(C-2-16,
4.5.1)

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

301 CREW TRAINING

30102 TRAINING DEVICES AND MEDIA

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.5); C-4(2.2.5.3d)

Revised: 9/26/85REQUIREMENTSREFER. NO.

- | | |
|---|------------------------|
| -04 <i>*(Provide the capability for preflight and on-orbit training, self-managed via interactive computer aided instruction and/or other technically advanced learning aids.)*</i> | 132(C-3,
 2.5) |
| -05 <i>*(Provide for efficient and cost-effective pre-flight training and on-orbit training and skill retention.)*</i> | 125(p 4-19) |
| -06 Crew interfaces, computer, audio, and video capabilities for training onboard and on the ground shall be compatible. | 132(C-4,
 2.2.5.3d) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- | | |
|---|---------------------|
| o Payload unique training will be provided by the customer. | 132,(C-2,
4.5.1) |
|---|---------------------|

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

301 CREW TRAINING

30103 TRAINING LOCATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.5)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

-03 Onboard training shall be designed to optimize crew interface, provide conducive environment, and establish commonality with ground training.

132(C-3-11,d

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

o Payload unique training will be provided by the customer.

132(C-2,
4.5.1)

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

3 CREW ACTIVITIES

301 CREW TRAINING

30105 TRAINING FOR ORGANIZATIONAL EFFECTIVENESS

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.5)

Revised: 9/30/85

REQUIREMENTS

REFER. NO.

-04 The ground and flight crews shall have diverse problem resolution training. 127,130

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

301 CREW TRAINING

30107 SPACE STATION GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.1)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

None

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

- o The growth of the Space Station from a crew of six to a crew of eighteen will not introduce design concept changes or operation requirements which impact the nature of the training program needs. 132

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

3 CREW ACTIVITIES

303 MAINTAINABILITY

30301 ACCESSIBILITY

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.6.4);C-3(3.2)

Revised: 9/30/85REQUIREMENTSREFER. NO.

- | | |
|---|-----------------------|
| -01 Replacement of subsystem equipment shall not require the removal or disconnection of other subsystem equipment nor shall replacement of an equipment module require the removal or disconnection of other equipment modules. | 317 |
| -02 Subsystems equipment shall be removable or replaceable by using installation handling devices & standardized onboard tool kits. | 317 |
| -03 The interconnecting plumbing & wire/cable access shall have suitable attachment length & mounting characteristics to facilitate removal/replacement. | 317 |
| -04 <i>*(ORU changeout shall be performed without shut down of critical systems.)*</i> | 146 |
| -05 Service points for fluid systems, including those for filling, draining, purging or bleeding, shall be in accessible locations. | 318 |
| -07 The containment of electrical cables, fluid lines & other subsystem components within trays and/or behind protective shields shall not preclude identification of components by decals, labels, color coding & other appropriate means. | 310(p 3-83) |
| -08 <i>*(All walls, bulkheads, hatches, & seals where integrity is required to maintain pressurization shall be accessible for inspection, maintenance or repair by shirt-sleeved crewmembers or EMU-suited crewmembers.)*</i> | 132(C-4-19, 2.1.11.2) |
| -09 Where mechanical fluid connectors are required, sufficient clearance for access and visibility shall be provided to allow for the installation of new connectors if damage occurs. | 124(#42, C-I-15) |

- 10 Accessibility to equipment attaching hardware, electrical connectors, electrical breakers/fuses, and plumbing shall be provided in all areas, without the need to functionally disconnect the ORU. Provisions shall be made for safely stabilizing removed ORUs which remain functionally connected, while access is gained into the ORU or behind its installed location. 124(C-I-15, #34)
- 11 No connector shall be lockwired. 124(C-I-15), #38)
- 12 Stowage shall not preclude access to component or avionic bays. 124(C-I-15), #39)
- 13 Wire harness & fluid lines shall be in cable trays for ready access. 124(C-I-13), #6)
- 14 Fold out/pull-out drawers & cabinets shall be used where possible to provide ease of access, and panels should be designed to be examined from different angles. 124(C-I-13), #5)
- 15 Fluid & gas connector shall be located and configured so they can be inspected, and so that leakage is obvious. 124(C-I-13), #7)
- 16 Provision shall exist for crew accessibility to automated functions via high-order language & audit trails. 124
- 17 Hardmounted components shall be no more than one deep in a bay. 124(C-I-15), #40)
- 18 The instrumentation system in each Space Station module shall be capable of detecting & isolating failures to the ORU level w/o requiring the removal of assemblies or components for the affected system. 146
- 20 Panel, console & rack mounted components with back, side, top or bottom mounted electrical connectors shall have slack cable lengths (maintenance loops) sufficient for removal of the connectors after the component has been extracted from its installed location unless adequate internal access is provided for visibility & manual manipulation. 310(p 3-83)
- 21 All items which are removable shall be sized to allow passage out of the Space Station. 124(C-I-13, #10)
- 22 Subsystems equipment supporting ECLS for safe IVA environment shall be accessible, removable and repairable by an EMU-suited crewmember. Crit Assumpt 6,7,9

CANDIDATE SOLUTIONSREFER. NO.

None

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|
|CRITICAL ASSUMPTIONSREFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

3 CREW ACTIVITIES

303 MAINTAINABILITY

30302 COMMONALITY

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.6.4);C-3(3.2)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

- | | |
|---|------------------|
| -01 The orbital replaceable hardware (ORUs) shall be designed for ease of on-orbit replacement. The hardware shall be designed or integrated to use common type fasteners, common connectors, and common tools, and to use the same packaging as appropriate. In addition, all connections shall be designed & labeled to preclude improper mating. | 321(p 26) |
| -02 ORUs shall be standardized where feasible. | 322(p 27) |
| -03 Standardized maintenance tool kits and maintenance aids shall be developed. | 124 |
| -04 The same type fasteners (size, tensile strength) shall be used for similar application throughout the end item of equipment. | 320 |
| -06 Parts that can be installed in more than one way will be clearly marked to indicate proper installation position. | 124(C-I-15, #36) |
| -07 Wherever practical, systems shall be designed such that repair can be accomplished by removal/replacement of subsystems or components. | 124(C-I-16, #50) |
| -08 There shall be commonality/standardization in integration of hardware/software across all modules. | 321 |
| -09 Utilize standard parts & items where possible. | 321 |
| -10 Provide for equipment racks where individual cards & assemblies can be changed out without affecting other equipment. | 124(C-I-15, #28) |
| -11 Generic repair capabilities shall be developed. | 124 |

CANDIDATE SOLUTIONSREFER. NO.

GEN It is recommended that where systems are duplicated, commonality be maintained up to at least the subsystem level throughout the Space Station to assure common procedures and software, thus reducing training requirements.	124(C-I-14, #19)
GEN It is recommended that standard commercial instruments and tools be used, or adapted for use in the onboard workshop. This equipment should include a standard interface that permits it to be controlled & monitored by a computer.	124(C-I-14, #20)

CRITICAL ASSUMPTIONSREFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

3 CREW ACTIVITIES

303 MAINTAINABILITY

30303 MAINTAINABILITY HARDWARE CHARACTERISTICS

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.6.4);C-3(3.2)

Revised: 9/30/85REQUIREMENTSREFER. NO.

- | | |
|--|------------------|
| -01 All connectors shall be designed to prevent glove and hand damage and to support gripping requirements. | 124 |
| -02 Wire harnesses shall be easily identified. | 124(C-I-15, #41) |
| -03 Bolts & screws used for installation of components, covers & panels shall have a head configuration which requires force only in the plane of rotation for installation or removal. Slotted head, Phillips head, Hi-torque etc., configurations shall be avoided. NOTE: Preferred are as follows: 1) Hex head or 12 point external wrenching with internal wrenching (allen-head) capacity, 2) Internal wrenching (allen-head) only. | 310(p 3-81) |
| -04 Panel, console and rack mounted components w/ back,side,top or bottom mounted electrical connectors shall have slack cable lengths (maintenance loops) sufficient for removal of the connectors after the component has been extracted from its installed location unless adequate internal access is provided for visibility and manned manipulation. | 310(p 3-83) |
| -05 Cable/Connectors shall meet the following requirement: <ul style="list-style-type: none">- mate & demate mechanisms shall provide positive connection feedback and/or visual feedback.- no unusual tools shall be required for mate/demate.- connectors shall be coded to prevent incorrect mating- connectors shall incorporate alignment provisions- connectors and cable runs shall be secured by a clamp and/or tie-wrapped every 18"- cables shall be restrained away from ORU | 310,124 |

installation route.	
-06 Attachment schemes shall be standardized to permit convenient equipment reconfiguration.	132
-07 Subsystems equipment shall be removable or replaceable by using installation/handling devices and standardized onboard tool kits. The interconnecting plumbing & wire or cable runs shall have suitable attachment, length, and mounting characteristics to facilitate removal and replacement.	124
-08 Minimize fasteners retaining components:	124
- Cam action or quick release where possible	
- Locate components so structure carries boost loads (do not suspend components requiring multiple high tolerance fasteners to carry boost loads)	
- Use captive fasteners	
- Temporary launch-load fasteners may be removed for on-orbit operation. These shall be clearly identified.	
-09 Hardware shall have guidepins to facilitate ease of mating.	124(C-I-16, #45)
-10 Hardware shall be designed so that maintenance can be performed with minimum use of tools & maintenance equipment.	310(p 3-79)
-11 Use 1) plug-in type installations and mounting techniques, 2) quick disconnect electrical & plumbing connectors.	124(C-I-16)
-12 Handling devices shall be used to the maximum extent possible in order to eliminate protrusions.	124(C-I-13, #3)
-13 The capacities shall be plainly marked on components requiring bearing/lubricant replacement.	124(C-I-13, #26)
-14 The need for soldering operations shall be minimized for repair, removal, replacement or disassembly.	383
-15 Painting and/or coatings shall not adversely affect removal or installation of fasteners.	155

CANDIDATE SOLUTIONSREFER. NO.

GEN Use recessed captive fasteners where possible with recessed allen-head screws & hexagon bolts.	124(C-I-13, #4)
GEN Make maximum use of wing nuts & pip pins.	124(C-I-13, #4)

GEN Minimize mechanical fluid connections.	124
GEN The use of passive cooling for components should be used where possible.	124
GEN Use pin size & density in connectors to minimize bent pins.	124

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

303 MAINTAINABILITY

30304 TESTABILITY/DIAGNOSTICS

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.3.4);C-4(2.1.9)

Revised: 10/24/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Fault detection/fault isolation shall be down to the ORU level.	324
-02 Provisions shall be available for onboard maintenance to be accomplished at the problem location or at some designated maintenance location.	132
-03 Equipment enabling maintenance to the required levels and simple diagnosis (e.g., multimeter, etc.) of circuitry, repair of hardware or replacement of elements shall be provided at the designated maintenance location.	132(C-4-54, 2.2.10.2)
-04 Avionics boxes or systems shall incorporate fault isolation down to the card level.	132
-06 Where built-in instrumentation cannot be provided for isolation & diagnostic functions, portable test equipment shall be provided for fault isolation to the replaceable component level. Portable test aids shall be provided for bench check and failure analysis.	124(C-I-16, #53)
-07 Provisions shall be included for inspection & assessment of the condition of Space Station systems on a scheduled basis. Capabilities shall be provided for onboard malfunction isolation with out requiring removal of the assembly or component from the system.	124(C-I-16, #52)
-08 Test plugs at or near maintenance locations shall be provided.	124(C-I-16, #56)
-09 Individual subsystems in the Space Station shall provide for fault isolation & subsystem checkout. Onboard checkout shall be automated & fault isolation & subsystem checkout will be performed in flight with ground assistance if required.	124

- 11 Subsystem design shall include a built-in test capability to facilitate detection & reporting of functional discrepancies. At a minimum, this capability shall enable failure detection at a functional path level in flight along with fault isolation. Time-critical events affecting crew safety or system survival shall be promptly annunciated.

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|---|-------------|
| GEN Utilize redundant functional paths or sub-systems so that their operational status can be verified w/o removal of ORUs. | 317(p 2-17) |
| GEN Onboard ORUs will perform checkout, monitoring, warning and fault isolation to a level consistent with the on-orbit maintenance approach. | 325 |

CRITICAL ASSUMPTIONSREFER. NO.

None

- * An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

303 MAINTAINABILITY

30305 ORU DEFINITION/CONFIGURATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.9);C(3.6.4)

Revised: 11/4/85REQUIREMENTSREFER. NO.

- | | |
|---|------------|
| -01 Critical ORUs shall be designed "fail operational" and fail safe. | 326 |
| -02 All critical life limited components/sub-systems shall be designed to allow on-orbit inspection. | 325 |
| -04 ORU design requirements:
1) full crew anthropometric range access,
2) tool swept vol. utilization, 3) changeout access & swept vol. envelope, 4) tool insert & engagement access, 5) visual access with & w/o head/body envelope, 6) illumination path(s) to work site, 7) ASE installation/integration access, 8) protective devices access & stowage, 9) connector/cable management & positioning, 10) motion of appendages & crew locations access, 11) large item transfer/translation/transport and crew access/safety, 12) access around or through structure and adjacent items, 13) visual access to guides, rails, alignment aids, etc., 14) access to fasteners, hold-down/release devices, clamps, etc., 15) access to umbilicals, e.g., over-rides, demate/remate features. | 327 |
| -05 Sharp edges on ORU's shall be avoided. | 326 |
| -06 All hardware which requires routine replacements (air filters, sorbent cartridges, etc.) shall be ORUs. | 324 |
| -07 Subsystems which contain liquids or high pressure gases and requiring maintenance shall be provided with disconnect valves at the ORU interface. | 324 |
| -08 ORU crew alignment aids shall be provided (e.g., center matching plates, ramp guides, cone standoff mounts, corner guides). | 323(p 2-3) |

- | | |
|---|--------------------|
| -10 ORUs shall incorporate provisions for a handle located as close to the center of mass as possible. If center of mass positioning is not feasible, provide for two handles. | 323(p 2-7) |
| -12 Replacement of an ORU shall not require removal of other ORUs to gain access. | 132(C-4-16, 2.1.9) |
| -13 Systems & subsystems shall be as functionally, mechanically, electrically & electronically independent as practical to facilitate maintenance. | 124 |
| -14 Critical systems shall be capable of undergoing maintenance w/o the interruption of critical services & shall be "fail safe" while being maintained. | 124 |
| -15 Connector & cable runs shall be secured by a clamp and/or tie wrapped every 18 inches (45.7 cm). | 323(p 2-10) |
| -16 When gloved handed ORU repair is required the following dimensions shall be observed: at least 8" (20.3 cm) high, no more than 19" (48.3 cm) deep and 10.5" (26.7 cm) wide. | 323(p 2-5) |
| -18 ORUs shall be designed to control spillage & release of gases. | 326 |
| -19 ORU design shall be compatible with logistics requirements. | 326 |
| -20 ORUs shall be labeled and keyed for easy identification, installation and removal. | 326 |
| -21 Equipment with high duty cycles shall be maintained as an ORU. | 324 |
| -23 ORU fasteners, connectors, & bonding techniques shall be standardized in order to minimize tool requirements & crew requirements & crew training. | 383 |
| -24 Where possible, components of a subsystem that are predicted to have similar mean time between failures (MTBF's) shall be grouped into one ORU. | 324 |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|--|-------------|
| GEN ORUs may be further divided into modular units that can be isolated & replaced at the Space Station central workshop area. | 317(p 2-16) |
| GEN ORUs may be either inside or outside of the station. | 124 |

GEN	Avoid maintenance requirements which involve more than removal/replacement of ORUs.	124(p 14)
GEN	The number of varied ORU sizes & shapes should be minimized.	

CRITICAL ASSUMPTIONSREFER. NO.

- o Designed such that maintenance does not introduce hazardous or destructive conditions.
- o Designed to provide adequate clearance & accessibility to facilitate maintenance.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

3 CREW ACTIVITIES

303 MAINTAINABILITY

30306 MAINTAINABILITY AIDS

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.6.4);C-4(2.1.9)

Revised: 9/26/85REQUIREMENTSREFER. NO.

- | | |
|---|-------------|
| -01 Tethers shall be adjustable and portable, and shall facilitate one-hand operation. | 324 |
| -02 Tactile feel or sound and/or light indicators shall be designed in equipment for positive alignment. | 324 |
| -03 Labels/Checkouts: 1) hardware labels shall utilize futura demibold or equivalent, 2) hazards instruction labeling shall be located very near item & not obscured, 3) labels shall be located in a consistent manner throughout the station, 4) decal labels shall be mechanically bonded to non-removable surface. | 324 |
| -04 High contrast color coding shall be used to supplement labeling to facilitate identification. | 124(C-I-17) |
| -05 Lighting shall be provided for the following means & manner: 1) portable, 2) emergency, 3) photographic, 4) experiment (a) reduce glare on work surface, (b) illumination of enclosed repair areas, (c) provisions for egress, translation illum. (d) work for maintenance should be between 108 & 323 lumens/m(sq) (10-30 foot candles), (e) portable lighting needs restraints. | 310 |
| -06 Remote maintenance aids shall be used in dangerous areas, hard to reach areas & as a time reduction & safety means for repairs. | 124 |
| -07 <i>*(A work surface, whether fixed or easily erectable, shall be provided in the work area. Simultaneous access to the work surface by at least two crewmembers and the ability to slope the work surface are desirable features. The design of the work surface shall include a means of restraining both large & small parts,</i> | 124(B-I-33) |

- tools, and equipment. There shall be a provision or capability to ground the work surface for crew safety.)**
- 09 Visual alignment aids shall be provided where needed. 324
 - 10 A flight data file for crew use during IVA & EVA operations through portable workstations shall be provided. This system shall be complemented by relevant media devices as appropriate. 132(C-3-13, 3.2)
 - 11 A capability shall be provided to bring internally or externally located ORU's into the pressurized work area to conduct maintenance. 132(C-3-13, 3.2)
 - 12 Appropriate documentation, standard and specialized test equipment, required to support operations & maintenance activities for hardware and software shall be provided. Specialized equipment shall be kept to a minimum. 132(C-3-13, 3.2)
 - 13 **(Design of equipment & systems requiring scheduled maintenance shall minimize the frequency & duration of crew involvement by minimizing requirement of aids, tools and maintenance equipments via used quick disconnect electrical & plumbing connectors, quick-release fasteners, & plug-in mounting techniques.)** 310(B-I-32)
 - 14 A means shall be provided at each maintenance location to secure tools & equipment. 124(C-I-16, #43)
 - 15 A computerized system shall be set up for tracking operating time & alerting the crew when preventive maintenance is required. 124(C-I-16, #27)
 - 16 Maintainability aids shall be designed in accordance to MSIS. 310

CANDIDATE SOLUTIONSREFER. NO.

- GEN Legholds: 1)crews have found on short & simple tasks gripping a stationary object between feet or legs gave two hand mobility - sometimes superior to shoe hold. 324
- GEN It is recommended that larger, less frequently used maintenance aids be stored on the Space Station external surface. 124(C-I-13, #10)
- 09 For visual alignment provide: 1. footprint; 2. guides; 3. alignment pins; 4. over-center device.

CRITICAL ASSUMPTIONSREFER. NO.

- o Panels, cable trays, consoles & equipment racks will be considered potential maintenance areas & designed accordingly.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

3 CREW ACTIVITIES
303 MAINTAINABILITY
30307 CREW SKILLS

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.6.3);C-4(2.1.9)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

- | | |
|---|---------------------------|
| -01 Limited maintenance procedures shall be imposed on the crew. | 132(B-7,
 2.5) |
| -02 The capability for the crew or the ground to modify, add, or delete software within the operating system shall be provided consistent with standard operational safeguards to prevent impact to station operations. | 132(C-3-13,
 3.2) |
| -03 The crew shall be the primary method for accomplishing scheduled, unscheduled & contingency maintenance. | 132(C-4-54)
 2.2.10.2) |
| -04 In-flight maintenance & training information shall be stored onboard to be used when required. | 124 |
| -05 Typical routine servicing tasks shall require skills to perform: 1) assembly & checkout, 2) instrument exchange or upgrade, 3) consumables resupply, 4) ORU replacement. | 132(C-4-12,
 2.1.2.4) |

CANDIDATE SOLUTIONS

REFER. NO.

04 Options include magnetic tape, disk, etc.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

303 MAINTAINABILITY

30308 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.9)

Revised: 9/26/85

REQUIREMENTS

REFER. NO.

-01 Crew facilities, equipment, and software shall be designed to support reconfiguration, growth, and update.

132(C-4-47)

-02 Test programs in software shall be designed to incorporate growth.

132(F-1-67)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

304 MAINTENANCE

30401 MAINTENANCE CONCEPT

CROSS REFERENCE TO RFP PARAGRAPH No: C(3.6.4)

Revised: 9/27/85REQUIREMENTSREFER. NO.

- 01 The Space Station maintenance concept shall represent an approach to on-orbit maintenance that satisfies the requirement for indefinite station life. | 132(C-19, 3.6.4)
- 02 The maintenance concept shall be to remove and replace the replaceable units at the ORU's on a scheduled or unscheduled basis. | 328(p 25, pp 4.2)
- 03 An on-orbit maintenance plan shall be provided to describe the anticipated Space Station maintenance effort. | 132(DR-07 pp 13.4, F-1-29)
- 04 **(Maintenance shall be performed on system components w/o the possibility of inadvertent shutdown of the whole system.)** | 132(C;3.6.4)
- 05 Provisions shall be made to easily plan, inspect, verify and implement replacement and/or repair of equipment associated with the platforms, core station, etc. | 124(p 3-13, pp 3.1.6)

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

304 MAINTENANCE

30402 SCHEDULED MAINTENANCE TASKS

CROSS REFERENCE TO RFP PARAGRAPH No: F(13.4.1);13.4.2 (p F-1-29)

Revised: 9/27/85REQUIREMENTSREFER. NO.

- | | |
|--|-------------------------------------|
| -01 Maintenance Plans/Maintenance Planning data shall contain information which defines EV and IV individual tasks required, time to perform the scheduled maintenance tasks and the frequency of tasks. | 328(p 28) |
| -03 The On-orbit Maintenance Plan shall address routine and preventive maintenance. | 132(DR-07,
 pp 13.4,
 F-1-29) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

- * An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

304 MAINTENANCE

30403 UNSCHEDULED MAINTENANCE TASKS

CROSS REFERENCE TO RFP PARAGRAPH No: 13.4.2 (Sec-F), 13.4.2 (p F-1-29)

Revised: 9/30/85

REQUIREMENTS

REFER. NO.

- | | |
|---|------------|
| -01 Maintenance Plans and Planning data shall | 328(p 28) |
| contain information which defines predicted | |
| unscheduled individual tasks, time to perform | |
| the tasks and the frequency of tasks log. | |
| | |
| -03 The On-Orbit Maintenance Plan shall address | 132(DR-07, |
| unscheduled maintenance. | pp 13.4, |
| | p F-1-29) |

CANDIDATE SOLUTIONS

REFER. NO.

- 01 A log of all maintenance activities shall be maintained, identifying equipment, problem, action taken, total time to perform the action, and person(s) performing the action, with space for special comment.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

304 MAINTENANCE

30404 TECHNICAL DOCUMENTATION

CROSS REFERENCE TO RFP PARAGRAPH No: 3.6.3 (Sec-C), 3.6.3 (p C-19)

Revised: 9/27/85REQUIREMENTSREFER. NO.

- 01 A plan shall be developed for Integrated Logistic Support areas including technical documentation for operations and maintenance. |132(pp 3.6.3 |p C-19); |328(pp 4.3.1,p 30)
- 02 Technical documentation shall comply with the following requirements:
- a. o OMD (Operations & Maintenance Document) |131(pp 1.3.12,p 41)
 - o should be reduced to bare essentials.
 - o OMD should be looked at from fresh view-point to streamline & simplify tasks
 - o Use as few words as possible
 - o Use as many illustrations as possible
 - o Identify special skills needed
 - o Identify all tools needed
 - o Identify special ways tools need to be used
 - o Identify optimal orientations
 - o Shall be easy to carry to workstation
 - o Number main steps in the procedure
 - o Highlight re-cycle/restart points within a procedure.
 - b. Assembly & start-up documentation shall be separate from routine maintenance information
 - c. Technical documentation shall be tailored to usage requirement.

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

DESIGN/OPERATIONS REQUIREMENTS

304 MAINTENANCE

30405 CUSTOMER SCHEDULED MAINTENANCE TASKS

Revised: 9/27/85

REFER. NO.

1124(pp 4.2.3
1p 4-10)

| 132(pp 3.1.6
| C-2-11)

REFER. NO.

REFER. NO.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

304 MAINTENANCE

30406 CUSTOMER UNSCHEDULED MAINTENANCE TASKS

CROSS REFERENCE TO RFP PARAGRAPH No: 4.2.3 (Sec-C, p C-1-19)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

-01 Service & repair tasks may result from contingencies. When a problem is detected the problem shall be defined & the Space Station crew role in the repair procedures, and the time line for repair shall be defined.

1124(p 4.2.3
1p 4-10)

-03 Space Station design shall facilitate unscheduled maintenance servicing of payloads. (124; 132 (p 3.1.6, (C-2-11))

1124; 132
1 (p 3.1.6,
1C-2-11)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES
304 MAINTENANCE
30407 CUSTOMER TECHNICAL DOCUMENTATION

CROSS REFERENCE TO RFP PARAGRAPH No: 3.6.3 (Sec C-19)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

- | | |
|---|---------------------------|
| -01 Customer technical documentation shall be developed to be used for operations & maintenance activities. | 328(p 17,
 pp 3.2.1.2) |
| -02 Payloads requiring maintenance or servicing shall be provided documentation standards by the Space Station program. | 124(p 4-7,
 pp 4.1) |
| | |
| | |
| | |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

305 SUPPORT EQUIPMENT

30501 FUNCTIONAL/LIMITATION

CROSS REFERENCE TO RFP PARAGRAPH No: 3.6.3 (Sec C-19)

Revised: 10/24/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Equipment shall be designed to incorporate the functional limitations specified in MSIS.	326
-02 <i>*(Sufficient tools and support equipment shall be provided onboard to perform all planned maintenance tasks.)*</i>	116(p 33)
-04 Tools shall be designed for one handed operations.	
-05 Power tools shall be considered for repetitive manual tasks.	

<u>CANDIDATE SOLUTIONS</u>	<u>REFER. NO.</u>
GEN Recommended are the following guidelines for equipment designs: Strength measurements, body motion, reach envelopes.	310
GEN Design studies should be implemented to develop a useful tool transport and retention device.	116(p 34)
GEN The following tools should be considered as support equipment: hacksaw, hand or power drill, whetstone, metal shears, crimper/cutter, soldering iron, crimpers, soldering gun, rubber mallet, leak detector, emery cloth, oil and polishing cloth.	116(p 35)
02 Off-the-shelf type hand tools may be adequate.	

<u>CRITICAL ASSUMPTIONS</u>	<u>REFER. NO.</u>
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None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES
305 SUPPORT EQUIPMENT
30502 COMMONALITY/STANDARDIZATION

CROSS REFERENCE TO RFP PARAGRAPH No: 3.6.3 (Sec C-19)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

- | | |
|---|-------------|
| -01 Single handles shall be designed for right & left hand operations. | 323 |
| -02 Size & type of attaching hardware & fastener head configurations shall be standardized throughout the vehicle to limit the number & kind of tools required to perform maintenance. Consideration shall be given to use of standard tools & the prospective onboard tool complement in selecting attaching hardware & fasteners. | 310(p 3-81) |
| -04 <i>*(Minimize the number of different & special tools required for maintenance.)*</i> | |
| -05 Throw angle for ratcheting tools shall be at least 90 degrees and shall allow operation for right or left handed crewmembers. | 383 |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|---|-----|
| GEN Common tool & socket hex size: | 310 |
| a) recommended tool socket/screw head engagement is 0.3 inch (.846 cm). | |
| b) a min. 1.0 inch-diameter (2.54 cm) socket clearance should be provided around fasteners & drive hex heads. | |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES
305 SUPPORT EQUIPMENT
30503 ARRANGEMENT

CROSS REFERENCE TO RFP PARAGRAPH No: 3.6.3 (Sec C-19)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-------------------------------|
| -01 A systematic approach shall be used in the arrangement of tools in tool kit. | 116(p 34) |
| -02 Stowage devices shall be equipped with means to prevent small items from drifting. | 132(C-4-49),
 pp 2.2.10.1) |
| -03 Stowage areas shall be compartmented to aid in the control of equipment during stowage & removal of equipment. | 132 |
| -04 Temporary restraint of equipment shall be available near stowage areas throughout the Space Station. | 132(C-4-49),
 pp 2.2.10.1) |
| -05 A systematic approach shall be used in stowing spares, materials, tools and maintenance aids throughout the Space Station. | 329 |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|-------------|
| 01 Form fitting tool restraints are not recommended. | 329(C-I-14) |
|--|-------------|

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES
305 SUPPORT EQUIPMENT
30504 LOCATION

CROSS REFERENCE TO RFP PARAGRAPH No: 3.6.3 (Sec C-19)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

-01 <i>*(Spares, materials, tools & maintenance aids shall be stowed in groups at locations throughout the station.)*</i>	116(C-I-16, #47)
-02 A maintenance workstation shall be provided which will contain both test & support equipment.	132(C-4-54, 2.2.10.2)
-03 A portion of the workstation shall contain a portable equipment section.	132(C-4-54, 2.2.10.2)
-04 A tool summary or listing shall be available onboard of the entire tool inventory.	116
-05 Tools shall be stored in areas which correspond to their functional application.	116

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

305 SUPPORT EQUIPMENT

30505 IDENTIFICATION/LABELING

CROSS REFERENCE TO RFP PARAGRAPH No: 3.6.4 (Sec C-19)

Revised: 9/27/85REQUIREMENTSREFER. NO.

-01 Equipment stowage location cues shall be provided.	132(C-4-49, 2.2.10.1)
-02 All connectors shall be labeled to preclude improper mating.	329(C-I-15, #57)
-03 Wire harnesses shall be well marked for easy identification.	329(C-I-15, #41)
-04 Labeling & identification practices shall be in compliance with MSIS.	310

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

306 ACTIVITY PLANG/SCHEDG

30601 DUTY CYCLES

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10)

Revised: 10/24/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-02 <i>*(The standard duty time for payload activities, and station upkeep per day and per week shall be TBD.)*</i>	128(p 89-100)
-03 Time shall be provided in crew schedules for the following activities: exercise, meals, recreation, hygiene, rest, & sleep periods.	128(p 89-100),344
-04 Mission length shall be set prior to flight and adhered to with extensions being added only after consultation with and agreement by the flight crews.	129(p 50)
-07 <i>*(Sleep periods shall include dedicated pre- and post sleep durations.)*</i>	128(p 96)
-08 Crews shall have time for preparation before and clean-up after major tasks.	131(p 146)
-09 <i>*(Work shift schedule shall be TBD.)*</i>	131(p 146)
-11 Physiological cycles and the factors/conditions that adversely affect them shall be considered in designing activities for crews.	131(p 163)
-12 Crew activities shall be designed to facilitate performance and to minimize fatigue.	128(p 89-100),384(p
-13 <i>*(The first 2-3 days of workload shall be light with individual needs taken into account.)*</i>	131(p 164) 102
-15 An allowance for short rest breaks during the day shall be included.	130(p 152-153)
-18 There shall be a scheduled overlapping of shifts for debriefings and activity orientation if 24-hour manning is required.	128(p 94) 131(p 154) 387(p 18-12)
-20 Scheduling systems shall provide for flexibility in task time allotments, job assign-	128,330

ments and accommodation for the unexpected.

- | | | |
|-----|---|------------------------------|
| -21 | <i>*(There shall be a maximum amount of EVA that a crewmember is scheduled to perform on a daily and weekly basis.)*</i> | 128(p 90-91)
385(p 72,79) |
| -23 | <i>*(The maximum number of IVA crew required during EVA shall be TBD.)*</i> | 385(p 72-79) |
| -28 | <i>*(Minimal amount of exercise, rest, privacy & recreation time required to maintain proper health motivation and alertness for different types of people over different mission lengths shall be TBD.)*</i> | 128(p 140-143) |
| -32 | <i>*(There shall be time for refresher or training prior to various tasks, related to the frequency of task performance.)*</i> | 128(p 111-112) |

CANDIDATE SOLUTIONS

REFER. NO.

- | | | |
|----|---|--------------------------|
| 07 | Schedule a 9-hour period per day, per person - 8 hours sleep and 1/2 hour prior and post sleep. | |
| 11 | If shift work is necessary, crewmembers should phase into it prior to mission. | 131(p 163)
130(p 164) |
| 12 | Provide weekend activities. | 130(p 154)
295(p 105) |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES
306 ACTIVITY PLANG/SCHEDG
30602 JOB ROTATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

-01 Flight crews shall have cross training and back-up skills where required.	131(p 160) 130(p 201) 129(p 54), 128,130(p 148, 151)
-04 Non-specialized skill tasks shall be rotated among crewmembers.	129(p 154) 295(p 103)
-06 Scheduling programs shall provide for job rotation.	128
-09 <i>*(Training methods shall facilitate crew skill levels and maintenance.)*</i>	128(p 111- 112)
-10 <i>*(The methods for crews to assign tasks during flight shall be TBD.)*</i>	128(p 97- 100)

CANDIDATE SOLUTIONS

REFER. NO.

GEN Provide on-board provisions for crew training and skill refreshment.	
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CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES
306 ACTIVITY PLANG/SCHEDG
30603 SCHEDULING METHODS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10)

Revised: 10/24/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 <i>*(Ground shall establish objectives, provide requirements and goals and do "global planning" while the crews do short-term onboard scheduling.)*</i>	128(p 89), 295(p 101), 131(v.II, p 3)
-02 <i>*(There shall be a balance of onboard autonomy and ground support to provide for cost effective scheduling.)*</i>	128(p 86,89, 97,98
-03 Ground shall be available to support flight crews when needed.	128(p 99)
-04 Crewmembers shall be involved in pre-mission planning.	131(p 144), 295(p 102)
-05 A "shopping list" of tasks with parameters, requirements, etc. shall be integrated for final scheduling.	131(p 160), 128(p 89)
-07 <i>*(Methods and requirements for developing "shopping lists" shall be TBD.)*</i>	128(p 98)
-08 To the extent possible, crews shall be relieved from routine, time-consuming functions which do not require judgement.	128(p 87)
-13 Inflight scheduling shall be computer aided.	128(p 98)
-16 <i>*(Scheduling systems shall include weighting factors of tasks in a given schedule.)*</i>	128(p 98- 100)
-17 <i>*(Protocols for ground input and access to onboard computer schedules, data and programs shall be defined.)*</i>	128(p 98, 109)
-19 <i>*(The onboard scheduling system shall be user friendly.)*</i>	128(p 69,73)
-20 Scheduling computer programs shall require a minimal amount of training.	132

-21 **(Methods to translate 'global planning' into onboard systems and daily planning parameters shall be defined.)** |128(p 69-73, 97)|

CANDIDATE SOLUTIONSREFER. NO.

- 05 Develop methods for assembling "shopping lists" and for identifying the task requirements in terms of space craft systems and crew skill mix.
- 08 Provide for automation and ground support to eliminate repetitive and time-consuming tasks.

CRITICAL ASSUMPTIONSREFER. NO.

- o An expert scheduling system will be available to accommodate the variables & data required for sophisticated requirements of scheduling space operations.
 - o Schedules will assume time for crews to train to do new or infrequent tasks.
 - o Facilities will be available for training.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

3 CREW ACTIVITIES
307 MAN-MACHINE ROLES

30701 MAN-MACHINE ROLE

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.7, 2.1.11)

Revised: 9/27/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Provide automation or autonomous control to achieve an optimal mix of human and machine resources and substitute "machine control" for human control where safety, productivity and cost effectiveness warrant.	1331(p 5-4) 132(C-3-14) 135
-02 Continuous system/subsystem monitoring and control by either the flight or ground crews shall not be required for normal Space Station system operations.	132(C-4-21, 22)
-03 Space Station systems/subsystems shall be designed such that any single credible failure will result in a safe condition. Subsequent crew action may be required to restore normal Space Station system operations.	132(C-4-21, 22)
-05 The capability for the crew to monitor all subsystem health and status data shall be provided.	132(C-4-21)
-06 The flight crew shall be able to change automated sequences and limits in real time and on line.	132(C-4-21, 22)
-07 Appropriate safeguards shall be provided to prevent inadvertant or unauthorized disabling of essential automated processes.	1331(p 5-4)
-08 System/subsystem verification shall be performed with a minimum of crew interaction and shall be capable of being initiated automatically or manually.	133(p 4-1, 5-6);131 (p 5-4);131 (C-3-14)
-10 Automated fault detection, isolation, and recovery shall give highest priority to crew life support and primary mission objectives.	1331(p 5-4)
-11 The crew shall be able to override any automatic safing or switchover capability of functional paths. All overrides shall be two-	132(C-4-21) 132(C-3-14) 1331(p 5-4)

step operations with positive feedback to the initiator that reports the impending results of the override command prior to the acceptance of an execute command. Separable functional paths shall be used to prevent single failures from causing both an unintended auto switchover and the inability to override it.

- 12 All automated systems shall provide easily accessible, complete "audit trails" for actions taken. 133(p 5.6)
- 13 Only processed results shall routinely progress upward through the hierarchy. Lower level data will be accessible at higher levels when required. 331(p 5-4)

CANDIDATE SOLUTIONS

REFER. NO.

GEN Develop a decision guide to be used to logically allocate space activities to alternative man-machine implementation modes based on the criteria of performance, cost and technical readiness. This decision guide should be a dynamic model which can accept updated information based upon changes in human and hardware performance (mainly hardware/software) and changes in confidence factors in human or equipment performance. 135(p 3.0, p 3.1-3.29) 133(p 9)

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

307 MAN-MACHINE ROLES

30702 GROUND MAN-MACHINE ROLES

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(3.3)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

-01 Automation shall be considered for ground systems design for effective resource utilization.

1132(C-3-14)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES
307 MAN-MACHINE ROLES

30703 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(3.3)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-------------|
| -01 The growth of the SSP capability shall accommodate increased levels of autonomy and automation/robotics. | 132(C-4-9) |
| -02 Review the recommendations of the Advanced Technology Advisory Committee (ATAC) and utilize automation and robotics at each proposed step of evolutionary growth of the Space Station in such a way as to attain the most productive man-machine mix and simultaneously, to identify the Space Station systems that represent the most promising opportunities for the advancement of automation technology both in space and on the ground. | 132(C-3-14) |
| -03 A phased progressive automation of both flight and ground elements shall be accommodated consistent with evolving system requirements, cost, applicable technologies, and the NASA Automation and Robotics Plan. | 132(C-4-16) |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

308 ORGANIZATION

30801 ORGANIZATIONAL STRUCTURE

CROSS REFERENCE TO RFP PARAGRAPH No:

Revised: 9/27/85REQUIREMENTSREFER. NO.

- | | |
|---|----------------------------|
| -05 There shall be enough cross training among crewmembers to permit backup and the potential for mutual assistance where desired & needed. | 295(p 192) |
| -06 There shall be well-defined and clearly delineated areas of responsibility, rules, obligations and guidelines made pre-flight. | 128(p 101)
 131(p 167) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES

308 ORGANIZATION

30802 METHODS TO ENHANCE COMPATIBILITY

CROSS REFERENCE TO RFP PARAGRAPH No:

Revised: 9/27/85REQUIREMENTSREFER. NO.

-02 Each flight crew shall train and work together prior to a flight.	295(p 153) 130(p 186)
-04 There shall be a clear definition of the objectives of the mission and the methods needed to reach goals.	295(p 190, 192)
-10 There shall be ground support potential for flight support in management and conflict resolution principles.	130(p228,237 238,246-248)

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES
309 STATION AUTONOMY
30901 AUTONOMY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.7)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

-01 All elements of the Space Station system shall be capable of routine operation independent of ground support after initial startup.	1333(p 5-4) 1131(p 3,4)
-04 Near term operations planning and scheduling will be performed onboard.	1132(C-3, 2.4.3c)
-06 The number of non-routine contingencies and emergencies requiring ground support for resolution shall be minimized.	1333(p 5-4)
-07 Platform design shall facilitate autonomous operations between scheduled servicing periods but shall not preclude ground intervention.	1132(C-4-14)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

3 CREW ACTIVITIES
309 STATION AUTONOMY

30903 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.4, 3.3)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

-03 Design the Space Station to incorporate
increasing levels of autonomy/automation
after IOC.

1132(C-4,
2.1.7)
|
|
|
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|

CANDIDATE SOLUTIONS

REFER. NO.

None

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|

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.

4 IVA SYSTEMS
401 WORKSTATIONS
40101 WORKSTATION DEFINITION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

- | | |
|---|---------------------------|
| -01 A crew station shall be defined as any location in the Space Station where a dedicated task or activity is performed. A workstation is a crew station which is exclusive of recreation, personal hygiene, food preparation, dining, housekeeping and other off-duty activities. | 132(C-4-54),
2.2.10.2) |
| -02 A thorough analysis of the requirements shall be done for each workstation to determine the task, operator activities, level of automation, tools, equipment, etc., necessary to meet the requirements. | 132(C-4-54) |
| -03 Each workstation shall meet the baseline safety requirements for the Space Station. | 132(C-4-54) |
| -04 Workstations equipped to perform identical tasks shall utilize prime/backup logic with appropriate safeguards against dual functional path commanding. | 132(C-4-54) |
| -05 Workstations shall satisfy the fail-safe criteria. | 132(C-4-54) |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|---|--|
| 01 Provide remote terminal with linkage to main computer system(e.g., at work stations, window workstations, laboratories, private quarters, and ward room). | |
|---|--|

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

4 IVA SYSTEMS

401 WORKSTATIONS

40102 WORKSTATION GENERAL REQUIREMENTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.5.3, 2.2.10.2)

Revised: 9/27/85REQUIREMENTSREFER. NO.

(NOTES: 1) Until the results of the pending study, Man-Systems Integration Standards (Ref. 149), have been finalized, it is recommended that, in conjunction with the requirements given in this subelement, References 141, 152 and 161 be used for design. Reference 381 could also be used as a secondary reference.

-01 Layout -

- a. Workstations shall be laid out by first considering the operator's needs, capabilities and range of physical dimensions and then designing workstation hardware to accommodate these requirements. 159(pp 4.4)
- b. Workstations shall be laid out in such a way that operator body motion required to perform all workstation functions shall be minimized. 159(pp 4.4)
- c. Workstations shall be designed such that all external distracting stimuli to the operator are minimized. 159(pp 4.4)
- e. Workstations shall be designed for 0-g body posture and variations which occur during long stay times in 0-g. 131(p 13)
- f. Workstations should be located to minimize interference with traffic areas. 131(p 13)

-02 Vision

- a. **(All workstations shall be designed assuming operation from a single Eye Reference Point for each body location area required by the station's function.)** 159(pp 5.2.1.4, 5.1.2.3.3)
- b. **(All visual displays shall be viewable from any angle less than or equal to TBD degrees from a line normal to and located at the center of the display.)** 159(pp 5.2.1.4)
- c. **(Legibility characteristics of all workstations shall conform to TBD requirements. The readability characteristics of all workstations shall conform to TBD.)** 159(pp 5.5)

- 03 Controls -
 - a. **(The characteristics of control devices shall conform to the most current standards.)** 159(pp 5.4), 155
 - b. Provide for crew intervention of automatic systems with feedback of system status including the reflection of the actual state of the system. 155, 131(p 39)
- 04 Displays -
 - a. **(The characteristics of displays shall conform to the most current standards.)** 159,155
 - b. Displays shall provide a graphic readout of data rather than lists of numbers when both actual value and trend data is required. 131,155, 159
 - c. Display information shall be limited to operationally relevant data, with access to supporting data as required. 131(p 410)
 - d. Caution and warning information shall be presented unambiguously, identifying the actual problem. 131(p 410)
 - e. Displays shall be standardized between systems and levels within systems. 131(p 410)
- 05 Workstation provisions: standardization of workstation equipment shall be maximized. 131(p 47)
- 06 Adjacent workstation with different "up" orientations shall be avoided. 159(pp 4.4.g)
- 07 A Remote Manipulator System workstation(s) shall be provided with both direct and CCTV viewing capability. 132(C-4-26, C-4-54)
- 08 Communications/Data Management - 132(C-4-32)
 - a. The fixed and portable Multiple Purpose Applications Console (MPAC) shall be a common design, functioning as a man-machine interface to the network operating system.
 - b. The MPAC shall provide command and control.
 - c. The MPAC shall provide simultaneous viewing of displays.
 - d. The MPAC shall provide crew override for subsystem operations.
 - e. The MPAC shall provide visibility into all subsystems.
 - f. The MPAC shall provide annunciation for catastrophic failures, consistent with established caution and warning philosophy.
 - g. The portable MPAC shall support both EVA and IVA operations.
 - h. The MPAC shall consist of the displays, monitors, interactive controls, and recording devices.

CANDIDATE SOLUTIONSREFER. NO.

None

1

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

4 IVA SYSTEMS

401 WORKSTATIONS

40103 WORKSTATION UNIQUE REQUIREMENTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.5.3, 2.2.10.1)

Revised: 10/24/85REQUIREMENTSREFER. NO.

- 01 Window Workstations - | 132(C-4-54);
All workstations associated with windows for | 131(p 1.2.1)
operations and scientific research, shall have
provisions for the following items where
dictated by the requirements analysis: mounted
voice tape recorder, event timer, means to
mount cameras, means to secure hand-held
cameras, small light, method to secure paper
and checklists, writing station, body
restraints, display and keyboard, maps, moving
map display with an optical device to view the
flight path, orbital maps to identify future
flight paths, method of measuring angles and
the horizon if appropriate, control of
adjacent lighting, easily deployed hood or
curtain to block interior light. The window
workstation shall accommodate two or more
people.
- 04 Laboratories -
a. A laboratory workstation shall be provided | 131(p 1.2.3)
with facilities for inflight maintenance and
repair in each lab module.
b. In those workstations with full or partial | 132(C-4-54)
hood, ventilation shall be provided.
- 10 **(A Remote Manipulator System workstation
shall be provided with both direct and video
viewing capability.)** | 132(C-4-26,
| C-4-54)

CANDIDATE SOLUTIONSREFER. NO.

- 04 General Laboratory | 131(p 1.2.3)
a. The laboratory equipment may include the
following equipment and facilities: counter or
work space, vise, small computer, cooling H2O
capability or equivalent, vents for noxious
fumes, electrical 3 phase and regulated D-C
power, electronic + diagnostic instrumentation
(oscilloscope, multitesters, small desk top |

- laser, microscope), small furnace - with levitators, soft and possible hard soldering, complete set of tools (some redundant), electronic supplies and components, access to space vacuum - cryo cold trap, pumping for hard vacuum - small chamber for high vacuum and controlled atmosphere experiments, multiple vacuum cleaner outlets, window for earth observation, work bench.
- b. May include the following tools and adequate restraints: volt meters, multimeter, microscopes, furnace, tools and equipment for repair (hacksaw, epoxy, hand drill, stone and file, power drill, rubber mallet, metal shears, files - rattail and round - soldering iron and vacuum attachment, crimpers, emery cloth, oil and polishing cloth, dykes, strong wire cutters, cable cutters, electrician's screwdrivers, screwdrivers, wrenches, leak detector, additional common tools).

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

4 IVA SYSTEMS
401 WORKSTATIONS
40104 PORTABLE WORKSTATION

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.);C-1(3.2.8.2)

Revised: 9/27/85

REQUIREMENTS

REFER. NO.

- | | |
|--|----------------------------|
| -01 Each portable workstation shall have a multifunction alphanumeric keyboard. | 132(C-4-48)
 133(p 453) |
| -02 Each portable workstation shall be capable of interfacing with primary fixed workstations and with the management communications and data systems. | 132(C-1-16)
 133(p 453) |
| -03 Each portable workstation shall incorporate a restraint system for securing the device at the using location. | 133(p 115) |
| -04 Each portable workstation shall incorporate an attached writing surface for note taking. | 133(p 115) |
| -05 Portable workstations shall be compatible with window workstations and maintenance usage. | 133(p 115) |
| -06 Portable workstations shall be compatible with usage in personal crew quarters and recreational areas. | 133(p 79) |
| -08 Portable workstations shall support both EVA and IVA. | 155 |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|----------------------------|
| GEN Each portable workstation shall have a multi-function liquid crystal display with bit-mapped capabilities. | 132(C-4-48)
 133(p 458) |
|--|----------------------------|

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

4 IVA SYSTEMS
402 DATA MANAGEMENT
40201 GENERAL DATA MANAGEMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-1(3.2.8); C-4(2.2.5)

Revised: 10/24/85

REQUIREMENTS

REFER. NO.

- | | |
|---|-------------|
| -02 The operational interface to the DMS shall be through Multipurpose Applications Consoles (MPAC), the distributed computer processing system, and dedicated controls on Data Management hardware. | 132(C-4-31) |
| -03 The initial DMS shall: a) support data base access, command and control, data transmission, computer and workstation resources for the DMS users and station subsystems; b) enable DMS users and subsystems to initiate on-line capabilities such as command data processing, program generation and debug, word processing, graphics, and electronic mail capabilities, health monitoring, imaging for proximity operations, display and performance and trend data, and appropriate payload interface monitoring. | 132(C-4-32) |
| -04 The initial DMS design shall provide the following:
a. Control initiation and status indications to/from all DMS users and subsystems for SSP operations independent of the source.
b. Distribution of DMS housekeeping data (timing, state vectors, RF communication, acquisition-of-signal/loss-of-signal, moding and pointing information, etc.) to the users. | 132(C-4-32) |
| -07 Computer output shall be in a form that is usable without interpretation or further analysis by the crew. | 131(p 398) |
| -08 Subsystem computers shall output either go/no-go or detailed information, as required. | 131(p 398) |
| -09 Displays shall provide a graphic readout of data rather than lists of numbers where both trend and actual value data is required. | 131(p 410) |
| -10 Display information shall be limited to | 131(p 410) |

operationally relevant data, with access to supporting data as required.	
-11 Caution and warning information shall be presented unambiguously, identifying the actual problem.	131(p 410)
-12 Displays shall be standardized between systems and levels within system.	131(p 410)
-14 Provide control and display for manual backup execution of critical functions.	131(p 397)
-16 Provide remote terminal with linkage to main system computer at workstations, laboratories, private quarters, ward rooms and other locations as required.	131(p 397)
-17 Provide secure ground station interaction with main system's computer.	131(p 397)
-18 The DMS shall employ common elements in the form of interface devices, subsystem data processors, and executive software overhead, distributed through all subsystems & modules.	133(p 451)
-22 Facilities Management shall be available to all subsystems and payloads. This service shall provide station level configuration management including logistics, resource allocation, and scheduling data for the crew's use. Tutorials for refreshing the crew on procedures shall also be provided from this service.	133(p 455)
-23 The DMS shall require minimal manual administrative support.	133(p 455)
-25 The DMS shall incorporate advanced data base management techniques, such as the use of the relational data model.	133(p 455)
-28 Safety requirement for all software programs, especially those performing control or integrating functions, shall be designed to default in a predetermined safe condition.	159(pp 5.15.1)

CANDIDATE SOLUTIONSREFER. NO.

GEN Provide the following kinds of hardware: keyboard terminals printers, disk drives, color CRTs, thermal printers for graphics, light pens, plotters, joy sticks.	131(p 397)
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CRITICAL ASSUMPTIONS

REFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

4 IVA SYSTEMS
402 DATA MANAGEMENT

40203 OPERATING SYSTEM

CROSS REFERENCE TO RFP PARAGRAPH NO: C-4 (2.2.5)

Revised: 10/4/85

REQUIREMENTS

REFER. NO.

-01 The DMS shall support a user-friendly language for the man-machine interface.

132(C-4-32)

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

4 IVA SYSTEMS
402 DATA MANAGEMENT
40205 MEMORY CAPABILITY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4 (2.2.5)

Revised: 10/4/85

REQUIREMENTS

REFER. NO.

- | | |
|--|----------------------|
| -01 Short term storage shall be provided onboard:
selected data shall be transferrable to
archival storage on the ground. | 132(C-4-33)

 |
| -02 Adequate mass storage capability shall be pro-
vided for the collection of station level
status concerning subsystems, inventory, and
proximity activities. | 133(p 454)

 |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

4 IVA SYSTEMS
402 DATA MANAGEMENT
40206 INTERFACE COMPATIBILITY

CROSS REFERENCE TO RFP PARAGRAPH NO: C-4(2.2.5.1)

Revised: 10/4/85

REQUIREMENTS

REFER. NO.

- | | |
|--|--------------------|
| -02 Provide an interface with space platforms and other robotic subsystems to support displays of remote sites, remote manipulations, and other unmanned proximity operations. | 132(C-4-33) |
| -04 Programs for hardware checks of interfaces and operating status shall not generate command signals which may activate or deactivate the item or system. | 159(pp 5.15.4.1.2) |
| -05 Interface devices and programs shall be compatible throughout the DMS. | |

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

4 IVA SYSTEMS
402 DATA MANAGEMENT
40207 MAINTENANCE/REPAIR

CROSS REFERENCE TO RFP PARAGRAPH NO: C-4(2.2.5)

Revised: 10/4/85

REQUIREMENTS

REFER. NO.

- 03 Where computer monitoring of systems is used, the system parameters state and change of state and the control input shall be monitored. |131(p 410)
|
-04 Maintenance information shall be presented |131(p 410)
in clear, easy to understand form and content. |

CANDIDATE SOLUTIONS

REFER. NO.

- 04 Provide maintenance information in a form |131(p 410)
that minimizes learning requirements and which |
enables accurate understanding. |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

4 IVA SYSTEMS
402 DATA MANAGEMENT
40209 APPLICATION PROGRAMS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4 (2.2.5)

Revised: 10/4/85

REQUIREMENTS

REFER. NO.

- | | |
|--|-------------|
| -03 Computer software capability shall be provided for the following: Scheduling, check-lists, station systems diagrams and information, systems monitoring, science, troubleshooting, maintenance information, inventory, housekeeping, word processing, dedicated PI links, replacing paper reports, etc., leisure activities, (games, etc.), educational courses (electronics, computers, etc.), maps, horizon sensors, orbit, etc., medical records. | 132(C-4-33) |
| -04 Software shall be "user-friendly". | 132(C-4-33) |
| -05 Versatile software which can be easily changed shall be provided | 132(C-4-33) |
| -06 Software systems with high reliability shall be provided. | 132(C-4-33) |
| -07 Provide a system capability to permit easy software modification by the flight crew without the need for software reverification. | 342 |
| -08 Provide onboard planning aids for computer generation of bar charts, time lines, and procedure sequences. | 342 |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|------------|
| 04 Provide self-prompting software with "error traps". | 131(p 410) |
| 05 Provide modularized software so that the user can tailor software to new/changing requirements. | 131(p 410) |

CRITICAL ASSUMPTIONSREFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

GROUP 5 REQUIREMENTS

The Requirements in this Group are marked "Preliminary." As noted in the Subelements List, Requirements (and Issues) were not prepared for all identified IVA/EVA Interface Elements. Full coordination with the Advanced EVA Systems studies (on RFP 9BE2-72-4-37P), which would provide significant contributions to this section, was not accomplished. The enclosed Requirements, therefore, represent an incomplete and preliminary version of identified requirements to support human productivity.

Requirements under Subelements 55XXX are applicable for a man-tended mode which assumes an unpressurized module. If the module is pressurized, these requirements are not applicable and requirements under Groups 1 through 4 apply as appropriate.

5 IVA/EVA INTERFACE

PRELIMINARY

501 AIRLOCK

50101 SYSTEMS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- | | |
|--|--------------------------|
| -01 The Space Station shall provide the IVA operations for the EMU. These operations include power, N2 purge verification, cooling, IVA pressure regulation, suit integrated check, airlock depressurization, repressurization, & service lines connection/disconnection. The EVA airlocks shall be capable of supporting these functions. | 132(C-4,
3.10.1a) |
| -02 As a design goal, operations normally associated with EVA crewmember pre-breathing shall take no longer than 30 minutes. | 132(C-4,
2.2.11.1a) |
| -03 The EMU shall be capable of being resized to an individual crewman in the airlocks. Equipment in the airlock shall be provided as needed to support resizing of the EMU. | 132(C-4,
2.2.11.1c) |
| -04 <i>*(TBD volume shall be available for an individual crewperson to resize the EMU within the airlock.</i> | 132(C-4,
2.2.11.1c) |
| -05 The EMU resizing penalty in the EMU will be less than .25 IVA man-hours per EMU. | 134(C-4,
2.2.11.1(c)) |
| -06 Provision shall be made on the Space Station to accommodate pressurized and unpressurized payload elements exterior to pressurized modules, including scientific airlocks. | 132(C-4,
3.1.2) |
| -07 <i>*(The scientific airlocks will be located TBD to accommodate pressurized/unpressurized elements exterior to the pressurized modules.)*</i> | 132(C-4,
3.1.2) |
| -08 The Space Station shall have pressurized laboratory modules for performing customer missions in a shirt sleeve environment, which may require external airlock support. | 132(C-2,
3.1.2) |

CANDIDATE SOLUTIONSREFER. NO.

None

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|
|CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

PRELIMINARY

501 AIRLOCK

50102 FUNCTIONAL/PERFORMANCE REQUIREMENTS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- | | |
|---|---------------------------------|
| -01 EVA airlocks shall support EVA in the vicinity of the Space Station during initial development, operational & growth phases by providing safe egress from & access to the pressurized Space Station by crewmembers in their EMU & such equipment as required. | 1132(C-4,
2.1.2.2) |
| -02 The Space Station shall have the capability to:
1. Support crew transfer from the pressurized orbiter cabin to the Space Station pressurized module with the crew suited.
2. Support suited crew transfer from the pressurized Space Station module to an unpressurized payload and/or docking adaptor. | 134(p 6) |
| -03 Two EVA airlocks shall be provided in the Space Station. | 1132(C-4,
2.2.11.1e) |
| -04 EVA airlock hatches shall be no less than 1.27 m. (50 in.) internal diameter & shall not be surrounded by structures which cause unusual body contortions or major reorientations to accomplish passage. | 1132(C-4,
2.2.10.1(g)
1e) |
| -05 Each EVA airlock shall accommodate the transfer of two suited crewmembers to & from space. | 1132(C-4,
2.2.11.01c) |
| -06 The EVA airlock shall accommodate the transfer of a standard equipment rack or the return of an incapacitated EVA crew person. | 1132(C-4,
2.2.11.2a6) |
| -07 The EVA airlocks shall be sized to accommodate donning/doffing the EMU by an unaided crewman. The airlocks may include provisions to aid a single crewman in donning or doffing an EMU. | 1132(C-4,
2.2.11.1c) |
| -08 The EVA airlock shall include provisions for the wireless voice communications assembly. | 1132(C-4,
2.2.6.2a) |

CANDIDATE SOLUTIONSREFER. NO.

None

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|
|CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

PRELIMINARY

501 AIRLOCK

50103 HYPERBARIC

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- | | |
|--|---|
| -01 One EVA airlock shall have the capability of serving as a hyperbaric treatment center for two crewmembers. The health maintenance facility will support and augment this capability. | 132(C-4,
 2.2.11.1c;
 C-4,
 2.2.10.2g.11 |
| -02 A small airlock between the hyperbaric chamber & the Space Station module shall be provided for passing medication, equipment, food and water. | 132(C-4,
 2.2.11.2a7) |
| -03 <i>*(The small airlock between the hyperbaric chamber airlock and the Space Station module will accommodate TBD wastes while the hyperbaric facility is in use.)*</i> | 132(C-4,
 2.2.11.2a7) |
| -04 In a hyperbaric chamber mode, the airlock pressure shall be raised to as high as 5.0 atmospheres above the ambient cabin pressure. | 132(C-4,
 2.2.11.2a7) |
| -05 <i>*(The hyperbaric chamber shall have TBD capability to transmit and receive data/line audio and video transmission to the HMF and ground.)*</i> | 131(p 427,
 p 431) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

501 AIRLOCK

50104 EVA SUPPORT

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- | | |
|---|--------------------------|
| -01 Space Station functions to reestablish pressure in a module shall be operable by EVA pressure suited crew members. | 132(C-4,
2.1.11.4(b)) |
| -02 The Space Station EVA airlocks shall provide support for the stowage & servicing of the EMU, EEU & general EVA equipment. | 132(C-4,
3.10) |
| -03 The EVA airlocks shall provide storage for the EMUs. | 132(C-4,
2.2.11.1c) |
| -04 The Space Station shall provide the IVA operations for the EMU. These operations include power, N2 purge, verification, cooling & pressure regulation, suit integration check, airlock depressurization, repressurization & service lines connection/disconnection. | 132(C-4,
3.10.1(a)) |
| -05 The EMU normally shall be reserviced as an assembly in the EVA airlock. | 132(C-4,
2.11.2(b)3) |
| -06 Automatic servicing & performance checkout of the EMU's and powered EVA equipment includes expendables regenerating, such as oxygen resupply & regeneration of time dependent processes, such as CO2 and H2O removal, heat rejection, & power storage. | 132(C-4,
2.2.11.2(b)) |
| -07 The EVA equipment service station shall automatically dry the EMU. | 132(C-4,
2.2.11.2b2) |
| -08 The airlocks shall include provisions for stowing the MMU outside the airlock. | 132(C-4,
2.2.11.1c) |
| -09 The airlocks shall support two EVA crewmembers during IOC & a minimum of four crewmembers for growth. | 132(C-4,
2.2.11.1a) |
| -10 Provisions for EVA equipment & spares stowage shall be provided on the outside of the EVA airlock. | 132(C-4,
2.2.11.2b1) |

- 11 **(The EMU repair on-orbit will be carried out at a TBD location.)** 132(C-19, 3.6.4)
- 12 The ECLSS shall support the capability to service & checkout the regenerative EMU within the airlock. 132(C-4, 2.2.11.2b3; C-4, 2.2.9.1f)
- 13 An equipment airlock shall be provided for the transfer of tools, parts & equipment without using the EVA airlocks. 132(C-4, 2.2.11.1g)
- 14 **(The equipment airlock will be located at TBD location and will be TBD dimensions.)** 132(C-4, 2.2.11.1g)
- 15 Capability for equalization of pressure across the inner hatch shall be provided for by the airlock. 132(C-4, 2.2.2.2c)
- 16 Control of depressurization and pressurization shall be possible from inside the Space Station and inside & outside the airlock. 132(C-4, 2.2.11.2a6)
- 17 **(Each airlock hatch side shall be equipped with TBD airlock display & status controls.)** 132(C-4, 2.2.11.2a6)
- 18 **(The EVA airlock hatch and TBD pressure controls shall be operable by an EMU crew-member, one-handed.)** 132(C-4, 2.2.11.2a6)
- 19 The inner airlock hatch shall permit through-viewing by the crew. The outer airlock hatch may provide viewing. 132(C-4, 2.2.2.2c)
- 20 The use of automated control and monitor devices, with appropriate operation feedback, shall be implemented for airlock operations as practical, and use of dedicated devices shall be minimized. 132(C-3, 3.3c)
- 21 Airlock automated functions shall be capable of being overridden or inhibited manually. 132(C-3, 3.3.b)
- 22 The space station crew must be able to override any automatic safing or switchover capability of functional paths in the airlocks. All overrides shall be two-step operations with positive feedback to the initiator that reports the impending results of the override command prior to the acceptance of an execute command. 132(C-4, 2.1.11.4a)
- 23 Airlock hatches shall be capable of being either opened or closed with manual control. 132(C-4, 2.2.10.1gle)
- 24 Each EVA airlock hatch shall have the capability of being locked/unlocked from either side. 132(C-4, 2.2.10.1gle)

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|--|--------------------------|
| -25 Airlock hatches shall require a maximum of 30 seconds for the manual opening or closing operation. | 132(C-4,
2.2.10.1gle) |
| -26 Airlock subsystems shall provide redundancy management & redundancy status to the flight or ground crew, as applicable. | 132(C-4,
2.1.10.2b) |
| -27 Alternate or redundant functional paths shall be separated or protected such that any event which causes the loss of one functional path shall not result in the loss of the alternate or redundant functional path(s), where appropriate. | 132(C-4,
2.1.10.4) |
| -28 The Space Station shall be able to tolerate any single credible failure, including the complete functional loss of any one airlock during all phases of the life of the Space Station. | 132(C-4,
2.1.11.2b) |
| -29 The airlock shall be automated to the fullest extent practical, using man's capability to provide a cost-effective alternative where appropriate. | 132(C-3,
3.3a) |
| -30 A phased degree of on-orbit autonomy shall be provided the airlocks consistent with evolving systems and operations requirements, cost, & applicable evolving technologies. | 132(C-4,
2.1.7) |
| -31 The EVA airlock shall support crew transfer from a pressurized payload or docked vehicle with a contaminated atmosphere to pressurized Space Station without contaminating the Space Station modules. | 134(p 7) |
| -32 <i>*(The EVA airlock sound level limits during depressurization/repressurization are TBD.)*</i> | 132,193,204 |
| -33 Checkout functions provided by the ECLSS service equipment, which are considered critical functions for EVA equipment operations, shall be continuously verifiable. | 132(C-4,
2.2.11.1c) |

CANDIDATE SOLUTIONSREFER. NO.

None

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CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

PRELIMINARY

501 AIRLOCK

50105 MAINTAINABILITY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- | | |
|--|-------------------------|
| -01 All airlock walls, bulkheads, hatches, & seals where integrity is required to maintain pressurization shall be accessible for inspection, maintenance, or repair by shirt sleeved crew members. | 132(C-4,
2.1.11.2d4) |
| -02 The transfer interconnections, between the airlock & the pressurized module, shall be accessible from inside the modules and shall be designed to be manually installed, removed, & serviced except where involving toxic or corrosive substances. | 132(C-4,
2.2.2.2d) |
| -03 The airlock hardware shall be restorable or repairable from all reasonable failures or damage. | 132(C-4,
2.1.9b) |
| -04 The airlocks shall have the ability to remain operational indefinitely through periodic inspection, maintenance, and replacement of components. | 132(C-4,
2.1.4.1) |
| -05 The airlock shall be designed for on orbit maintenance to ensure indefinite station life. | 132(B,
2.5) |
| -06 Airlock support for EVA equipment servicing capabilities shall be based on 10 EMU and 10 EEU reservices per week initially and for 20 EMU and 20 EEU reservices per week for the growth station. | 132(C-4,
2.2.11.2b2) |
| -07 Replacement of an ORU in the airlock shall not require removal of other ORU's to gain access. | 132(C-4,
2.1.9g) |
| -08 Airlock hardware shall be designed to facilitate on-orbit & ground maintenance, inspection, & repair with maintenance performed on-orbit to the Orbital Replaceable Unit (ORU) level. | 132(C-4,
2.1.9e) |
| -09 System & subsystems hardware & software shall | 132(C-4, |

- | | |
|--|------------------|
| be designed such that preventive & corrective maintenance activities for the Space Station system minimizes the use of available crew time. | 12.1.9h) |
| -10 Airlock subsystems shall be designed such that maintenance does not introduce hazardous or destructive conditions. | 132(C-4, 2.1.9g) |
| -11 Airlock subsystems shall be capable of undergoing maintenance without the interruption of critical services & with minimum interference with other airlock operations. | 132(C-4, 2.1.9d) |
| -12 Easy removal, repair, and/or replacement of all airlock equipment to the ORU level shall be provided. | 132(C-3, 3.2.c) |
| -13 The airlock shall provide adequate clearance & accessibility to facilitate maintenance. | 132(C-4, 2.1.9e) |
| -14 The airlock subsystems shall provide for monitoring, checkout and fault detection, and isolation to the ORU level without requiring removal of ORU's. | 132(C-4, 2.1.9c) |
| -15 Functionally independent airlock subsystems shall be developed, as appropriate, in order to facilitate maintenance and operations, both in flight and on the ground. | 132(C-3, 3.2.j) |
| -16 Airlocks shall be designed such that the airlocks & their major assemblies can be replaced at any time during the life of the Space Station. | 132(C-4, 2.1.9i) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

501 AIRLOCK

50106 MATERIALS PROCESSES

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- | | |
|---|--------------------------|
| -01 When automatic actuation is required in the airlock, electromechanical actuation systems shall be the primary candidate. | 132(C-4,
 2.2.2.1c) |
| -02 The airlock requirements for materials & process control will be established by NASA. In the interim, SE-R-0006, "General Specifications, NASA JSC Requirements for Materials and Processes", (JB400016) & MSFC Document 57D506B, "Standard Materials and Process Control", (JB400041) shall be utilized. | 132(C-4,
 2.1.11.3b) |
| -03 Airlock materials shall be selected on the basis of function and suitability, to include: extended life, technological maturity, manufacturability, inspectability, contamination characteristics, specific strength, compatibility, availability, cost and safety. | 132(C-4,
 2.2.1.3) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE
501 AIRLOCK
50107 COMMONALITY

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- | | |
|---|---------------------|
| -01 Common components shall be used in all airlocks (EVA, equipment, and scientific) where possible. | 132(C-4,
 2.1.5) |
| -02 Equipment to be used in the airlock shall be designed to be compatible with other on-board systems for the purpose of maintenance and repair. | 132(C-3,
 3.2i) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

501 AIRLOCK

50108 SAFETY/TRAINING

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- | | |
|---|------------------------|
| -01 Safety critical and mission critical airlock subsystems are those whose function, if lost, would produce a condition endangering on-board personnel or prevent the accomplishment of a critical mission objective. Safety & mission critical subsystems shall be designed to be fail-operational/fail-safe/restorable, as a minimum (except primary structure & pressure vessels in rupture mode & premature firing of pyrotechnics). This criteria applies during all operational phases except initial assembly and maintenance. Some degraded performance following the first failure is not precluded by the fail-operations/fail-safe requirement. | 132(C-4,
2.1.10.1) |
| -02 During assembly & maintenance, critical airlock components shall be fail-safe as a minimum. | 132(C-4,
2.1.10.1) |
| -03 Non-critical airlock components & ground support hardware shall be designed to be fail-safe/restorable. | 132(C-4,
2.1.10.1) |
| -04 Redundant functional paths of airlock subsystems shall be designed to permit verification of their operational status in flight without removal of ORU's. | 132(C-4,
2.1.10.2a) |
| -05 Safety & mission critical airlock subsystems shall be designed such that no signal instrumentation failure shall cause the loss of a redundant functional path where appropriate. | 132(C-4,
2.1.10.2b) |
| -06 Airlock subsystems shall be such that one failure does not cause additional failures. | 132(C-4,
2.1.10.3) |
| -07 Airlock support shall be provided to the crew in the non-hazardous areas of the Space Station for 28 days. | 132(C-3,
2.2.b) |
| -08 The airlocks shall have the emergency | 132(C-3, |

operational capability for 28 days for IVA transfer to a rescue orbiter.	2.2.b)
-09 As a minimum, fail operational, fail safe, & restorable capability shall be provided in safety and mission critical systems within the airlocks.	132(C-3, 2.2c)
-10 The airlock design shall reflect in order of precedence (1) elimination of hazards by removal of hazardous sources and operations by appropriate design measures, (2) prevention of hazards through the use of safety devices, (3) control of hazards through the use of warning devices, special procedures and/or emergency devices.	132(C-4, 2.1.11.1)
-11 Detection, containment, & control shall be provided in the airlocks for emergencies such as fires, toxic contamination, depressurization, malfunction of mechanical systems and rotating equipment or structural damage.	132(C-4, 2.1.11.2a1)
-12 The airlock shall provide isolation from the remainder of the Space Station or any adjacent module which contains confined hazardous or toxic materials.	132(C-4, 2.1.11.2a2)
-13 Rapid emergency EVA egress from the airlock shall be possible with minimal EMU functional checkout.	132(C-4, 2.2.11.1a)
-14 Systems, subsystems, or equipment located in Space Station airlocks shall be capable of tolerating the differential pressure & depressurized condition without resulting in a hazard.	132(C-4, 2.1.11.2d5)
-15 Emergency life support, damage assessment, & medical equipment appropriate to the airlocks shall be readily accessible to the crew within airlocks.	132(C-4, 2.1.11.2n)
-16 The airlock design shall be such that the need for extensive crew training is minimized.	132(C-3, 2.5a)

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

504 STOWAGE/STORAGE

50401 STOWAGE OF EMU EQUIPMENT

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- | | |
|---|---|
| -01 EMU equipment shall be stowed as close to its use location as practical. | 132(C-4-49) |
| -02 Labeling shall be provided to allow easy identification of stowed items. | 132(C-4-49) |
| -03 Design shall provide for easy access, removal and restowage of EMU. | 132(C-4-49) |
| -04 Temporary equipment restraints shall be provided near storage areas. | 132(C-4-49) |
| -05 External surfaces of storage equipment shall be free of protrusions, sharp corners, and recesses or holes. | 132(C-4-50) |
| -06 Stowed equipment shall be accessible to 5th percentile Oriental female through 95th percentile American male. | 132(C-4-47) |
| -07 <i>*(EMU shall be stowed per TBD requirements.)*</i> | 132(C-4-59)
348(p II-86)
349(p 5-1) |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|---|----------------|
| 02 Utilize color graphics as an aid in storage location identification. | 132(C-4-49) |
| 02 Use windows in stowage lockers for easy identification of stowed gear. | 132(C-4-54) |
| 02 Provide computer inventory of stowed gear. | 132(C-4-49) |
| 02 Use pictures and sketches to illustrate locations and de-stowage of stowed gear. | 347(p 150-151) |

CRITICAL ASSUMPTIONSREFER. NO.

o EMU to be stowed in airlock.

132(C-4-59)

348(p III-86)

o 2 EMU'S per airlock, 2 airlocks.

132(C-4-59)

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

504 STOWAGE/STORAGE

50402 EEU EQUIPMENT

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

-01 EEU equipment shall be stowed as close to its use area as practical.	132(C-4-49)
-02 Provide easy access, removal and restowage of EEU equipment.	132(C-4-49)
-03 Provide easy identification/location of EEU equipment.	132(C-4-49)
-04 Provide temporary equipment restraints near storage areas.	132(C-4-49)
-05 External surfaces of storage facilities shall be free of hardware protrusions, sharp corners, corners, recesses or holes.	132(C-4-50)
-06 Stowed equipment shall be accessible to 5th percentile Oriental female through 95th percentile American male.	132(C-4-69)
-07 Adequate thermal and micrometeoroid protection shall be provided.	132(C-4-69)
-08 <i>*(Location and stowage configuration of EEU equipment shall be TBD.)*</i>	132(C-4-59) 347(P 150- 151), 348 (p III-118)

CANDIDATE SOLUTIONSREFER. NO.

03 Provide computer inventory of EEU equipment.	132(C-4-50)
03 Use pictures and sketches to illustrate location and access to EEU.	347(p 150- 151)

CRITICAL ASSUMPTIONSREFER. NO.

o EEU to be stowed outside of airlock.	132(C-4-59)
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o A minimum of 4 EEU's to be stowed on "full-up" Space Station. 132(C-4-59)

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

504 STOWAGE/STORAGE

50403 RESTRAINTS/TETHERS/EVA TOOLS

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- | | |
|---|--|
| -01 Storage facilities shall be provided for EVA tools, restraints and tether. | 347(p 134)
 349(p V-VI) |
| -02 Identification of storage facility contents and operating procedures shall be provided for each drawer, cabinet, etc. | 347(p 150)
 132(C-4-49) |
| -03 Stowage facilities for EVA equipment and spares shall be provided inside station as well as outside of dedicated EVA airlock. | 132(C-4-60,
 C-4-69) |
| -04 <i>*(Stowage for EVA restraint/tether items shall be located and configured per TBD.)*</i> | 132(C-4-49;
 61)347(p 134
 349(p V-VI) |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|--|--|
| 01 Provide stowage facilities of size TBD for EVA tools, restraints and tethers. | |
| 02 Provide equipment locker identification using placards, labels, color graphics, pictures and sketches. | |
| 03 Provide identical stowage facilities within station and on exterior just inside and just outside dedicated EVA airlock. | |

CRITICAL ASSUMPTIONSREFER. NO.

- | | |
|--|-------------|
| o Provisions for storage of EVA equipment will be required within station and on exterior. | 132(C-4-69) |
| o An equipment airlock for transfer of EVA equipment/tools etc. will be provided | 132(C-4-60) |

independent of EVA airlock.

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

PRELIMINARY

504 STOWAGE/STORAGE

50404 EMU/EEU SERVICING & CHECKOUT EQPT. STORAGE

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- | | |
|--|--|
| -01 Storage facilities shall be provided for equipment associated with servicing and checkout of EMU and EEU. | 347(p 134) |
| -02 Identification of storage facility contents and operating procedures shall be provided for each drawer, cabinet, etc. | 347(p 150)
 132(C-4-59) |
| -03 Stowage facilities shall be located such as to provide effective checkout & servicing of airlock stowed EMU and exterior stowed EEU. | 132(C-4-59) |
| -04 <i>*(Servicing & checkout equipment for EMU/EEU shall be stowed and configured per TBD.)*</i> | 132(C-4-4,
 59,61)
 349(p 134) |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|--|--|
| 01 Provide stowage facilities of size TBD for equipment associated with servicing and checkout of EMU and EEU. | |
| 02 Provide equipment locker identification using placards, labels, color graphics, pictures and sketches. | |
| 03 Provide storage of this equipment in up to three locations-interior, airlock and exterior. | |

CRITICAL ASSUMPTIONSREFER. NO.

- | | |
|--------------------------------|-------------|
| o EMU stowed inside airlocks. | 132(C-4-59) |
| o EEU stowed outside airlocks. | 132(C-4-59) |

- o EMU resized in airlocks. 132(C-4-59)
 - o EMU normally serviced as an assembly in airlock. 132(C-4-61)
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

504 STOWAGE/STORAGE

50405 MAINTENANCE & REPLACEMENT PARTS

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- | | |
|--|-------------------------------|
| -01 Stowage facilities shall be provided near use areas for EMU/EVA maintenance & repair eqpt. | 347(p 137)
 132(C-4-49) |
| -02 Stowage facilities shall provide provisions for tools, spares and maintenance equipment. | 347(p 283) |
| -03 Temporary equipment restraints shall be provided near stowage and use areas. | 132(C-4-49) |
| -04 <i>*(Parts, spares & tools for EVA support shall be stowed per TBD.)*</i> | 132(C-4-49,
 59)347(p 284 |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|---|----------------------|
| 01 Locate storage areas near dedicated EMU & EVA equipment airlocks. | 132(C-4-59) |
| 02 Design and dedicate work area to include effective stowage facilities to accommodate all aspects of routine as well as contingency maintenance operations. | 347(p 284,
 285) |
| 03 Make use of portable tool caddies. | 347(p 284) |
| 03 Establish tool display in "home shop" style to provide quick visual inventory. | 347(p 282) |

CRITICAL ASSUMPTIONSREFER. NO.

- | | |
|---|-------------|
| o Maintenance and repair of EVA equipment to be performed inside Space Station. | 132(C-4-61) |
| o Station to incorporate equipment airlock for transfer of tools and EVA equipment without use of EVA airlocks. | 132(C-4-60) |

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

504 STOWAGE/STORAGE

50406 PAYLOAD SUPPORT EQUIPMENT STOWAGE

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- 01 Storage provisions shall be provided for payload support equipment within station. | 349(p V-VI)
| 132(C-4-68)
- 02 Identification of storage facility contents and operating/destowage procedures shall be provided for each container. | 347(p 150)
| 132(C-4-49)
- 03 Storage facilities for all payload support equipment shall be grouped together and provide for a wide range of item sizes and functions. | 132(C-4-68)
- 05 **(TBD provisions shall be made for stowage of payload support equipment.)** | 132(C-4-4,
| 50, 60)
| 349(p V-VI)

CANDIDATE SOLUTIONSREFER. NO.

- 01 Provide universal stowage facility. |
- 02 Stowage containers dedicated to payload. |
- 03 Identify/mark all support equipment and have a separat removable labeling system to accommodate all possible equipment. |

CRITICAL ASSUMPTIONSREFER. NO.

- o Equipment associated with specific payload support functions will be provided inside the Space Station. | 132(C-4-68)

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

PRELIMINARY

504 STOWAGE/STORAGE

50407 GROWTH

CROSS REFERENCE TO RFP PARAGRAPH NO: C-3.2.2.9

Revised: 8/14/85

REQUIREMENTSREFER. NO.

-01 *(TBD EVA equipment stowage capacity provisions shall be made to anticipate effective and feasible levels of Space Station growth.)*

|132(C-11)
|248(C-11)
|

CANDIDATE SOLUTIONSREFER. NO.

01 Use of modular stowage facility system to quickly and effectively add or subtract EVA equipment stowage as the use of EVA equipment changes.

|347(p 134,
|137)
|

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

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5 IVA/EVA INTERFACE

506 PERSONAL HYGIENE

50601 IN-SUIT BODY WASTE MANAGEMENT

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-2.2.11.1

Revised: 8/14/85

REQUIREMENTS

REFER. NO.

- | | | |
|-----|--|---|
| -01 | In-suit body waste management shall provide for male and female urine collecting devices. | 350(p 34)
132(C-4-57)
132(C-4-60) |
| -02 | System design shall prevent the return of odors, particles, biotic contaminants and/or toxicants to the Space Station environment. | 350(p 34)
132(C-4-57)
132(C-4-60) |
| -03 | <i>*(The EMU waste shall be transferred to the Space Station waste management system, post-EVA per TBD requirements.)*</i> | 350(p 34)
132(C-4-57)
132(C-4-60) |
| -04 | In-suit body waste management provisions shall accommodate body wastes for an EVA maximum of 8 hours. | 350(p 34)
132(C-4-57)
132(C-4-60) |
| -05 | <i>*(Urine collection and management shall be TBD.)*</i> | 350(p 34)
132(C-4-57) |

CANDIDATE SOLUTIONS

REFER. NO.

- 01 The inner cooling garment should provide for the restriction of perspiration to undergarments.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

506 PERSONAL HYGIENE

50602 SUIT HYGIENE

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11.2)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- | | |
|--|-----------------------------|
| -01 Pressure suit drying equipment shall include a blower, hoses, and desiccant for removal of moisture inside the suit following use. | 351(p 10,34)
 104(p 13) |
| -02 There shall be provisions for EMU sterilization. | 351(p 10,34)
 104(p 13) |
| -03 There shall be provisions to enable wipe out of the EMU interior with antiseptic to control contamination from urine, fecal matter, vomitus, saliva, or blood. | 351(p 10,34)
 104(p 13) |
| -04 <i>*(Cleaning of the EMU shall be per TBD design requirements.)*</i> | 351(p 10,34)
 104(p 13) |

CANDIDATE SOLUTIONSREFER. NO.

- | | |
|--|-----------|
| GEN The exterior of the suit should be checked for radiation before crewmembers handle and disassemble it. | |
| 01 There should be suit dryer motors that can be set to turn off automatically. | 128(p 81) |
| 01 The suit should have the capability to be stored in an ultraviolet sterilization chamber. | |

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE
507 TRAINING/PROCEDURES

50701 GENERAL

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.5)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

-01 Teleoperations that support EVA activities will be trained by simulation on the ground. Refresher training will be provided on-orbit.	135,132
-02 Escape, emergency and decompression procedures will be trained on the ground using simulation where practical.	347
-03 EMU suiting procedures and suit maintenance will be trained on the ground.	135
-04 EVA communications and monitoring procedures will be trained on the ground.	382

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

PRELIMINARY

551 MAN-TENDED

55101 GENERAL LAYOUT

CROSS REFERENCE TO RFP PARAGRAPH No: (See below)

Revised: 8/19/85

<u>REQUIREMENTS</u>	<u>REFER. NO.</u>
-01 Space Station automated functions shall be capable of being overridden or inhibited by an EMU crewmember during the man-tended operations.	132(C-3, 3.3b)
-02 The use of all control & monitor devices, and appropriate operation feedback, shall be designed for use by EMU suited crewmembers.	132(C-3, 3.3.c)
-05 <i>*(TBD volume shall be allocated per EMU crew-member function to facilitate task/activity accomplishment & minimize or avoid confinement effects.)*</i>	131
-06 The geometric arrangement of compartments shall provide the necessary & adequate EMU access, egress volumes, & envelopes to all functions within the Lab module while in the man-tended mode & while conducting repair, maintenance or structural work in the de-pressurized module.	124(p 10-22)
-07 Internal hatches and doors shall be configured to allow EMU pass-through without body reorientation.	124(p 10-23)
-08 System and subsystem hardware & software shall be designed to provide adequate EMU clearance & accessibility to facilitate maintenance while in the unpressurized, man-tended module.	132(C-4, 2.01.09(e)) Crit Assumpt 6,7,9
-09 Floor to ceiling height shall be compatible with the 0-g neutral body posture of the specified EMU anthropometric range parameters.	132(C-4, 2.2.10.2d)
-10 Drawers & cabinets shall be equipped with suitable restraints to allow access, removal & restowage of equipment and accommodate EMU use.	132(C-4, 2.2.10.1f)
-11 Drawer stowage devices shall accommodate EMU	132(C-4,

gloved access operations.	2.2.10.1f)
-13 Provisions, e.g. electrical outlets, shall be available for on board maintenance, to be accomplished at potential problem locations or at some designated maintenance location and provide EMU accessibility.	132(C-4, 2.2.10.2c)
-14 <i>*(Functional group interrelationships of compartments shall be a prime consideration in the basic man-tended layout arrangement. TBD compartment/area adjacency criteria will be applied in determining the optimum relationships between the various activity areas.)*</i>	132(C-4, 2.2.10.01)
-15 Redundant accommodations for complete command & control of the man-tended station shall be provided for EMU use.	132(C-4, 2.1.11.4b)
-17 The man-tended Lab module shall be designed to facilitate system growth & accommodate EMU access and operations through use of modular & subsystem design.	132(C-4, 2.1.5)
-18 <i>*(Facilities & equipment shall be designed to support EMU reconfiguration, growth, and update through TBD methods.)*</i>	132(C-4, 2.2.10.1)
-19 <i>*(The station module will have a workbench/workshop equipped with TBD standard tools & diagnostic aids, coupled with the EMU maintenance procedures.)*</i>	124

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- o The man-tended unpressurized station module will be replaced for manned IOC.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

PRELIMINARY

551 MAN-TENDED

55102 TRAFFIC FLOW

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1g)

Revised: 8/19/85REQUIREMENTSREFER. NO.

- 02 Flow patterns for the man-tended module should minimize the distance large masses are transported, reduce as much as possible the congestion caused by masses transported through tight areas, & reduce the frequency of transport. 135(p 12, 2.1.2)
- 05 Passageways & hatches shall be clearly marked as to clearance dimensions to facilitate EMU & container transport. 137(p 2-1)
- 06 Equipment located near traffic routes & work-station areas shall be designed to accommodate EMU crew movement. 132(C-4, 2.2.10.1g)
- 07 **(Locate man-tended workstations according to EMU working envelope criteria.)** 131(1.2)
- 13 A clear zone shall be established contiguous with each hatch & bulkhead opening, requiring all surfaces be free of hardware protrusions, sharp corners and edges, & recesses or holes & meet the EMU requirements. 132(C-4, 2.2.10.1g)
- 15 The EMU restraint systems shall be stowable so as to leave the aisle completely clear & with no surfaces protruding. 132(C-4, 2.2.10.1g)
- 16 Hoses & cables shall be restrained and out of the way of EMU crewmembers traffic paths. 138(p 34)
- 18 Provide dual escape routes from all activity areas to the extent feasible to serve in the event that one route is impassable. 139(p 22)
- 19 The Space Station shall provide crew & equipment with sufficient restraints & locomotion aids to enable the EMU crewmembers to function efficiently & effectively. 124(p 10-23)
- 21 Hardware shall be designed to withstand in- 131

- advertent collision & use as a mobility aid or temporary restraint.
- | | |
|---|---------------------|
| -22 The Lab module shall be provided with visual markings & other cues to provide the crew directional & spatial orientation for use with mobility & restraint devices. | 137(2.1, p 2-1) |
| -23 Provide a means of preventing inadvertent operation of switches & circuit breakers by a EMU crewmember. | 131 |
| -26 Equipment restraints shall be provided to anchor every item of use that is not permanently attached to the station. | 132(C-4, 2.2.10.1g) |
| -27 Handholds/handrails shall be strategically located to assist entry/exit at all Lab work areas. | 132(C-4, 2.2.10.1g) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- o The man-tended unpressurized station module will be replaced for manned IOC.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

PRELIMINARY

551 MAN-TENDED

55103 DECOR

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10)

Revised: 8/19/85REQUIREMENTSREFER. NO.

- 01 **(The man-tended module shall be provided with visual markings & other cues to provide the crew directional and spatial orientation for use with mobility/restraint devices and maintenance and repair work per TBD requirements.)**
- 02 **(Markings and labels on all equipments shall be standardized throughout the station for ease of readability by EMU-suited crew per TBD requirements.)**

137(p 2-1,
2.1) Crit
Assumpt
6,7,9

132(C-4,
2.2.10.1a)
Crit Assumpt
6,7,9

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- o The man-tended unpressurized module will be replaced for manned IOC.
- o Special criteria is needed within module for clear readability of all labels and markings for EMU-suited crew.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

PRELIMINARY

551 MAN-TENDED

55104 MATERIALS

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1)

Revised: 8/19/85REQUIREMENTSREFER. NO.

- | | |
|--|--------------------------|
| -01 Interior areas of the Space Station shall be devoid of sharp-edged surfaces and meet EMU accommodation requirements. | 132(C-4,
 2.2.10.1) |
| -02 A means of avoiding injury or EMU damage from inadvertent contact with protrusions shall be provided. | 131 |
| -03 All areas of the station shall be conveniently maintainable by an EMU crewmember. | 132(C-4,
 2.2.10.1h) |
| -06 Interior materials & finishes shall be selected to withstand contact and abrasion from the EMU-suits and equipment and to minimize particulates in the environment. | 142
 (4.1.5.2) |
| -07 All transparent surfaces, e.g., displays, windows, etc., shall be scratch/mar resistant and guarded where crew or equipment movement may come in contact with these surfaces and facilitate on orbit replacement by an EMU crewmember. | 142
 (4.1.5.2) |

CANDIDATE SOLUTIONSREFER. NO.

None

|

CRITICAL ASSUMPTIONSREFER. NO.

- o The man-tended unpressurized station module will be replaced for manned IOC.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

PRELIMINARY

551 MAN-TENDED

55105 ANTHROPOMETRY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1)

Revised: 8/19/85REQUIREMENTSREFER. NO.

- | | |
|--|----------------------------|
| -01 <i>*(The design of the crew interface subsystems shall accommodate the TBD EMU anthropometric range.)*</i> | 132(C-4,
 2.2.10.01(b) |
| -03 The man-tended layout, facilities & activities shall be designed to the EMU 0-g neutral body posture. | 124(p 10-23) |
| -04 Workstations shall be designed to accommodate EMU 0-g body posture. | 131 |
| -05 The design of passageways & locomotion aids shall consider the EMU neutral body positions. | 124 (C-4,
 2.2.10.1g) |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- o The man-tended unpressurized station module will be replaced for manned IOC.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

551 MAN-TENDED

55106 MODULARITY

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.1.2, 2.1.5, 2.2.10.1)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- | | |
|--|---|
| -01 <i>*(Crewmembers shall be able to reconfigure interior volume arrangements by TBD methods to accommodate revised configurations.)*</i> | 131(1.1.3)
 145(p 2-5) |
| -02 <i>*(Interfaces between primary and secondary structure and between subsystems and their attachment to structure shall be standardized per TBD to minimize human involvement in repair maintenance, etc.)*</i> | 132(2.2.1.2)
 144(p 3-84,
 85) |
| -03 Interior design shall facilitate system growth through use of modular and subsystem design. | 132(C-4,
 2.1.5) |
| -05 Modular stowage lockers shall be incorporated into the overall interior arrangement of the station. | 132(C-4,
 2.2.10.1f)
 124(p 3-5) |
| -06 System design shall provide interfaces that prevent mislocation of equipment modules or intermixing of equipment interface connectors. | 136 |
| -07 Removal & temporary relocation of partitions/modules which must be moved for wall access (as for leak repair) shall be designed for EMU-suit gloved hand operation. | Crit Assumpt
 6,7,9
 131(p 1.1.3) |
| -08 <i>*(Design equipment racks per TBD criteria to provide flexibility in various module configurations.)*</i> | 145(p 2-5) |
| -09 Equipment racks shall be a standard width. | 143(p 7-3,
 pp 7.1.3.2)
 144(p 3-84,
 pp 3.4.1.1.1 |
| -10 <i>*(Provide utility interfaces in modular design per TBD criteria.)*</i> | 144(p 3-84,
 85, pp
 3.4.1.2,3.4.
 1.3,3.4.1.4) |

-11 **(Provisions shall be made for periodic upgrading and modification per TBD requirements.)**

|131(p 1.3.13
|
|

CANDIDATE SOLUTIONS

REFER. NO.

- | | | |
|----|--|---------------------|
| 01 | Design modular interior walls and dividers which can be repositioned as required. Design modular structure and attach points for walls and dividers. | 131(1.1.3)

 |
| 02 | Design modular equipment units with standard, repeated fasteners and structural attachments. |

 |

CRITICAL ASSUMPTIONS

REFER. NO.

- o There will be no habitability accommodations for the man-tended configuration.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

PRELIMINARY

551 MAN-TENDED

55107 WINDOWS/REMOTE VIEWING

CROSS REFERENCE TO RFP PARAGRAPH No: C-1(2.2.3.2);C-2(3.1.1)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- | | |
|---|-----------------|
| -01 Provide a means of achieving the greatest possible reduction in reflectance on all surfaces of all window panels, except for the outermost surface. | 148,149,167 |
| -02 The window characteristics shall be compatible with thru-window photographic requirements. | 148,149,167 |
| -03 <i>*(Observation windows shall have a minimum diameter of TBD inches to provide binocular viewing through a window simultaneously by two 95th percentile EMU-suited American male crewmembers.)*</i> | 159,131 |
| -04 <i>*(Provide a filter and opaque shade capable of controlling and preventing the transmission of ultraviolet, visible, infrared, microwave and ionizing radiation. Window shielding shall be coordinated with other radiation protection work to achieve less than allowable dose levels. Internal EM environment to be within ACGIH, ANSI guidelines, coordinate with laser and RF systems design.)*</i> | 166,151 |
| -05 <i>*(The haze value for the window assembly shall be less than TBD percent at the installed angle.)*</i> | 149,153,
163 |
| -06 <i>*(The light transmission of the window assembly shall not be less than TBD percent of the visible spectrum at the installed angle. Ultraviolet, infrared, microwave, and ionizing radiation shall be controlled to less than TBD allowable limits.)*</i> | 163
151 |
| -07 <i>*(Surface Distortion</i> | 352 |
| a. Wavefront deformation shall not exceed 200 nanometers, peak to peak, over any 4" diameter area across the surface of the window, for all angles up to 45 degrees from normal. | |
| b. Parallelism shall not be exceeded by more than | |

- 2 arc seconds between the two surfaces of one panel; and shall not exceed 30 arc seconds between panels.*
- c. *Surface scratch and dig shall be 60/40 per MIL-D-13830B or better.)**
- 08 The installation angle of the window assembly shall not be less than 65 degrees measured from the horizontal reference (25 degree angle of incidence). 148,149,150, 154
- 12 Windows shall be impact resistant and have multiple panels to protect against micro-meteorite or debris impact. 132(C-4-23) 352
- 13 **(The architectural arrangement of equipment near the windows shall allow adequate space for the performance of operational, maintenance, and recreational tasks by two 95th percentile EMU-suited American male crewmembers.)** 131, 132(C-4, 2.2.10.1d)
- 14 **(Provide TBD windows to allow viewing in all directions.)** 131,158
- 15 Provide workstation windows in accordance with operational viewing requirements (Refer to 55401). 131
- 16 Provide a window in each airlock and hatch door allowing a 45 degree field of view in all directions from nadir. 147
- 17 **(Provide cleaning equipment and materials which are compatible with the window surfaces.)** 131
- 18 **(Provide easily installed and removable inner and outer window protective covers per TBD criteria in addition to radiation attenuators. The outer window cover shall be controlled remotely from within the interior.)** 131,154,151 352
- 19 Provide optical viewing devices and/or closed circuit television where external visual monitoring tasks cannot be performed by direct vision. (Direct vision is preferred.) 156,157

CANDIDATE SOLUTIONSREFER. NO.

None

|

CRITICAL ASSUMPTIONSREFER. NO.

- o Windows will be required for man-tended payload operations.

o There will be glass panes in the windows even though the man-tended modules will be unpressurized.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

PRELIMINARY

551 MAN-TENDED

55109 STOWAGE/STORAGE

CROSS REFERENCE TO RFP PARAGRAPH No: (See below)

Revised: 8/19/85REQUIREMENTSREFER. NO.

- | | |
|--|---------------------------|
| -01 Equipment shall be stowed as close to its use location as practical. | 132(C-4-49) |
| -02 Labeling shall be applied to all stowage compartments for easy readability by EMU-suited crewmembers. | 132(C-4-49) |
| -03 Temporary equipment restraints shall be provided near storage areas. | 132(C-4-49) |
| -05 External surfaces of storage equipment/ compartments shall not have protrusions or sharp corners, recesses, or holes. | 132(C-4-49) |
| -06 Adequate thermal and micrometeoroid protection shall be provided. | 132(C-4-69) |
| -07 Stowage for spares, EVA tools, restraints and tethers shall be provided. | 347(p 134) |
| -08 Stowage for all checkout, calibration and inspection equipment & tools shall be provided for both payload equipment and station systems. | 347(p 134)
349(p V-VI) |
| -09 Stowage compartment designs shall provide for retention of all contained items until individually accessed by the crewmember. | 132(C-4-49) |
| -10 <i>*(TBD volume shall be provided for stowage of spares, tools, restraints, tethers and test equipment.)*</i> | Crit Assumpt
6,7,9 |
| -11 <i>*(TBD provisions shall be made for refrigeration, humidity, and other environmental controls, as required.)*</i> | Crit Assumpt
6,7,9 |

CANDIDATE SOLUTIONSREFER. NO.

- 11 Provide the capability to remotely monitor and
control all climate control functions of
specialized containers.

CRITICAL ASSUMPTIONSREFER. NO.

- o The man-tended unpressurized station module
will be replaced for manned IOC.
- * *An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

PRELIMINARY

552 MAN-TENDED

55201 INTERNAL ENVIRONMENT

CROSS REFERENCE TO RFP PARAGRAPH No: see below

Revised: 8/14/85REQUIREMENTSREFER. NO.

-01 **(Provide TBD payload-caused atmosphere and water contamination detection, monitoring, and control.)**

| 132(C-4,
| 2.1.11)
|
|
|

CANDIDATE SOLUTIONSREFER. NO.

None

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CRITICAL ASSUMPTIONSREFER. NO.

- o In the man-tended mode, the only internal atmosphere and water management systems will be those associated with life sciences payloads.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

552 MAN-TENDED

55202 EXTERNAL ENVIRONMENT

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.3)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- | | |
|--|--------------------------|
| -01 *(Monitor radiation dose rates and accumulated dose within Space Station, and record data by TBD methods.)* | 179,184,354
104(p 31) |
| -02 *(Monitor dose rates and short-term accumulated doses to each crewmember/visitor, and keep exposure records by TBD methods.)* | 179 |
| -03 *(Windows shall provide attenuation of external ionizing radiation to allowable limits by TBD methods.)* | 179,354 |
| -04 *(Provide TBD shielded volume for radiation-sensitive materials.)* | 354 |
| -05 *(Protect humans in Space Station from excessive exposure to ionizing space radiation by TBD methods.)* | 179,180 |
| -06 *(Ensure crew has realistic perception of radiation hazards via TBD methods.)* | 353 |
| -07 Minimize crew radiation dose levels and keep accumulated doses below allowable levels during all activities. | 179
104(p 31) |
| -08 *(Monitor trapped proton flux, energy flux and energy spectrum external to the Space Station by TBD methods, and record data.)* | 179 |
| -09 *(Monitor trapped electron flux and energy spectrum external to the Space Station by TBD methods and record data.)* | 179 |
| -10 *(Monitor accumulated fluence and LET spectrum of high-Z high-energy (HZE) cosmic ray particles within the Space Station working areas by TBD methods.)* | 180,181,182
104(p 31) |
| -11 *(Protect crew central nervous systems (including eyes) from HZE particles by TBD | 180,181,182
104(p 31) |

- methods (e.g., by fixed head shielding in EMU helmets).)**
- 12 **(Protect occupants of Space Station from excessive exposure to solar flare event radiations by TBD methods).)** 179,180
132(C-4-51)
 - 13 **(Develop contingency plans for crew protection during large solar flare events).)** 179
132(C-4-51)
104(p 31)
 - 14 Protect crew from excessive levels of solar UV, visible and infrared radiation per American Council of Government Industrial Hygienists, Physical Agents in the Work Environment (1984). 183
 - 15 **(Protect crew by TBD methods from effects of a TBD acceptable fraction of all micrometeorites).)** 355
 - 16 **(Provide TBD means of adding space radiation shielding (if Space Station program growth results in increased particle fluence).)** 179,180
132(C-4-51)
104(p 31)

CANDIDATE SOLUTIONSREFER. NO.

- GEN Levy design requirement on Space Station to maximize inherent structural shielding, with low-Z material on exterior, higher Z materials inside.
- 02 Provide wearable, readable personnel dosimeters for daily cumulative radiation dose for all crew and visitors.
- 03 Coordinate window shielding design with other radiation protection work to achieve less than allowable dose levels.
- 04 Coordinate with other Space Station shielding requirements/design.
- 05 Determine radiation shielding thickness requirements for each radiation type, based on crew dose allowables and current radiation flux data.
- 06 Provide radiological physics and radiation effects training for crew/visitors.
- 07 Schedule EVA's (and other activities as well) considering space radiation environment (e.g., during orbital periods of low dose rates).
- 08 Provide fixed active dosimeter system external to the Space Station, reading proton flux and spectrum (use differential shielding); read

- out multiplexed in Space Station. Provide recordkeeping system, possibly integrated with interior and personnel dose data base.
- 09 Provide fixed active dosimeter system external to the Space Station, reading electron flux and spectrum; read out multiplexed data and record in the Space Station, possibly integrated with other radiation data bases.
 - 11 Provide fixed passive devices to record influence and LET spectrum of high-Z particles in crew's workstations. Provide on-board read-out capability. Readout periodically in orbit and record data.
 - 12 Determine probabilities for solar flare events having specific proton flux vs. time and event fluence/spectra as basis for risks vs. shielding trade. Study "safe haven" concept for crew protection. Provide a communication link to solar flare warning/alert network.
 - 13 Study rescue mission options and scenarios; preplan how to rearrange massive equipment in Space Station to provide additional shielding (perhaps by computer modeling); preplan, by computer modeling, the orbital changes that would reduce solar flare radiation to allowable levels. Investigate feasibility of medical prophylaxis and/or treatment for alleviation of radiation syndrome effects. Coordinate all these studies to develop optimum plans.
 - 14 Attenuate solar UV, IR, and visible radiation in spacecraft windows to occupational safe levels.
 - 15 Provide micrometeorite shields; coordinate with radiation shielding. Study "safe haven" concept for micrometeorite protection; coordinate study with solar flare protection requirements; examine size-frequency distribution to establish an allowable risk level.
 - 16 Study potential growth options for development of appropriate means of adding radiation protection.

CRITICAL ASSUMPTIONSREFER. NO.

- o The man-tended unpressurized lab module shall be tended by EMU-suited crew.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

552 MAN-TENDED

PRELIMINARY

55203 INDUCED ENVIRONMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.3)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- 01 **(Communication/radar antennas on STS and Space Station must have controlled pointing to preclude beaming TBD excessive EM energy into module working spaces.)** | 132(2.2.10.1.j.3(b)(2)
- 02 Monitor (actively) broad band RF/microwave electric and magnetic field strengths in Space Station working spaces; alert crew if excessive; record data. | 185,353 (Table 1)
- 03 **(Control RF leakage from all electronic on-board (inside Space Station) equipment to TBD levels.)** | 186
- 04 **(Design/operate communication/ranging lasers on Space Station so that neither direct nor reflected irradiance levels in the working spaces exceed TBD units.)** | 132(2.2.10.1.j.3(b)(1)), 187 (Tables 3-7) 188
- 05 Monitor, during laser-on times, the irradiance levels at laser wave lengths at all work-stations near windows; alert crew if excessive, and record data. | 187
- 06 **(Provide crew protection from TBD synergistic effects of system growth, e.g., contamination, debris, radiation, etc.)** | 353

CANDIDATE SOLUTIONSREFER. NO.

- 02 Place E- and H-field meters in all compartments where RF energy can penetrate; cover at least frequencies of on-board radars/communication systems. |
- 03 Levy leakage specifications on all on-board electronic equipment. | 186
- 04 Place active detectors, sensitive to appro- |

priate wavelengths near window workstations, |
with readout and recording equipment. |

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.

5 IVA/EVA INTERFACE

PRELIMINARY

552 MAN-TENDED

55204 AREA LIGHTING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.c)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- 01 A. **(The intensity of the general illumination lights shall be a minimum of TBD ft-C.)** 352 (pp 7.2.3)
 B. The lighting level shall be measured on the 352
 primary surface using a ft-candle meter, (pp 7.2.3)
 using a 98% reflectance magnesium oxide (MgO)
 disk. The intensity of the general illumi-
 nation lights after 4800 hours of operation
 shall not be less than 60 percent of the orig-
 inal intensity. Distribution of light shall
 not exceed a ratio of 7:1.
- 02 Minimum lighting levels and direction of 352
 illumination shall be specified in all areas
 and for specific tasks, consistent with JSC-
 19517, (J8400037); JSC-SC-L-0002A, (J8400080);
 and MIL.STD. 1472, (J00032).
- 03 Locate light sources away from normal line of 189(pp 7.2)
 sight.
- 04 The light source shall be recessed to the 189
 greatest extent possible and shall provide (pp 7.2.1)
 even illumination from its location. The
 fixture shall be designed to direct light into
 the desired areas with no visual discomfort to
 the crewmembers.
- 05 **(Provide surface reflection for ceilings of 103
 TBD % and for walls of TBD %.)**
- 06 **(Provide distributed luminaries with a color 352
 temperature of TBD degrees K or higher, as
 needed for special applications.)**
- 07 **(Provide fixtures/luminaries whose exposed 131
 surfaces do not exceed TBD degree C when
 operated at maximum output.)**
- 08 Portable lights shall be provided. 131
- 09 The light source shall be incandescent or 189

fluorescent lamps and shall be illuminated within one second after being energized.	
-10 Fluorescent lights shall be protected from breakage and escape of mercury.	190
-11 Locate light controls at convenient locations throughout the Space Station in accordance with usage requirements.	132
-12 Lighting controls shall be provided with an on-off and continuously variable dimming-to-low level control capability. Lowest level shall remain visible.	189
-13 Exterior light controls shall be located both at the exterior and interior of the Space Station at convenient locations.	132

CANDIDATE SOLUTIONSREFER. NO.

None

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CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

552 MAN-TENDED

55205 NOISE & VIBRATION

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.1.j.4)

Revised: 8/14/85REQUIREMENTSREFER. NO.

-01 <i>*(TBD equipment noise and vibration specifications shall be applied.)*</i>	193 378
-02 <i>*(Design equipment mounting and location to reduce noise & vibration conduction between station hardware and EMU hardware at work-stations.)*</i>	132(C-4-53) 377(p 116)
-03 Prepare a noise and vibration control plan.	192(p 14) 379(p 3)
-04 <i>*(Perform analytical estimates of EMU noise.)*</i>	192(p 34)
-05 Plan, perform, evaluate data from noise tests.	192(p 15)
-06 Perform flight data acquisition and evaluation; update analysis methods.	192(p 54) 132(C-4-53)
-07 Refer to Subelements 20501-20506 for acoustic noise concerns.	---

CANDIDATE SOLUTIONSREFER. NO.

None

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CRITICAL ASSUMPTIONSREFER. NO.

- o In the man-tended mode, due to the lack of a sound conducting atmosphere within the Space Station modules, the acoustic requirements pertain only to the acoustic environment within the EMU. The acoustic environment is created by EMU hardware, communications, or by conduction between the Space Station hardware & EMU structures (helment,backpack,shoes).

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

552 MAN-TENDED

55206 CREW SAFETY

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-3(2.2) & C-4(2.1.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

- 01 **(TED emergency detection and control equipment shall be provided.)** | 132(C-4,
| pp 2.1.11)
|
- 04 All failures of safety critical SSPE systems | 132(C-4
| shall be annunciated to the flight and/or | pp 2.1.11.2)
| ground crew. |
|
- 06 The crew shall not be exposed to electrical | 132(C4,
| power leads. Ground-fault protection shall be | 2.1.11.2k)
| provided for circuitry or power distribution |
| busses directly accessible by the flight crew. |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- o It is assumed that crew safety will be | 132(C-4,
| considered early in the Definition and | pp 2.1.11.1)
| Preliminary Design so that the order of
| design precedence will be fully
| implemented.
- o All mission payloads will be designed
| fail-safe so that any caustic/corrosive
| liquid spillage will be contained from
| spreading.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

552 MAN-TENDED

55213 WASTE/TRASH MANAGEMENT

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4-50

Revised: 8/19/85

REQUIREMENTS

REFER. NO.

-01	*(IBD design shall be provided to control the handling and disposal of waste/trash within the man-tended module.)*	1304(P 84)
		1132(C-4-50)
		1Crit Assumpt
		16,7,9

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1304(P 84)
1132(C-4-50)
1Crit Assumpt
16,7,9

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CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

- o The man-tended unpressurized station module will be replaced for manned IOC.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

552 MAN-TENDED

55214 SUPPLY SUPPORT

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.14)

Revised: 8/14/85REQUIREMENTSREFER. NO.

RESUPPLY REQUIREMENTS

- 01 Spares for hardware items shall be provided throughout duration of flight. | 131(Vol 1, p 60)
- 02 Provide preventive maintenance materials and supplies such as wires, tape, lubricant, straps, lamps, & fuses. | 131(Vol 1 p 124)
- 03 **(Provide TBD amount and type of spares to be compatible with initial design and resupply capability, and provided in accordance with maintenance analyses/reliability estimates/risk considerations/on-board limitations.)** | 131(Vol 1, p 131)
- 04 Provide for resupply of consumables, delivery of spare/repair parts, propellant resupply, delivery or return of payloads or of new or damaged elements, return of waste and of processed materials. | 124(p 3-13)
- 07 The capability for rapid assessment of additions, deletions and changes to equipment stowage shall be provided, using graphic analysis techniques, mockups, trainers, and simulated lockers. | 172(p 25)
| 100(p 50)

INVENTORY MANAGEMENT AND CONTROL

- 08 **(Provide an efficient and easy-to-use TBD Inventory Management System (IMS) which will provide Space Station maintenance and trouble-shooting procedures, status of consumables, remove-and-replace information, and location reference of on-board resources.)** | 124(p 10-3)
| 128(p 54)
| 131(Vol 1, p 247)
- 09 **(Output of inventory data to be in exact TBD format as used by crew and compatible with TBD realtime uplink for on-board presentation.)** | 128(p 54)
- 10 Information shall be indexed with as many cross categories as possible. | 128(p 54)

- 11 **(Location of spares is to be readily determined by TBD methods.)** 131(Vol. 1, p 131)
- 12 Spare parts shall be readily identifiable. 131(Vol. 1, p 131)
- 13 **(Similar items, such as 35 mm film, shall be clearly distinguishable and uniquely identifiable by TBD approach.)** 131(Vol. 1, p 247)
- 14 "User-friendly" software will be required for inventory purposes, among other uses, and shall be prepared and provided in a manner that can be easily changed to permit tailoring for unique cargo or mission characteristics. 131(Vol. 1, p 411)
- 15 Inventory records shall be structured such that the total pedigree of each listed item can be easily retrieved. 131(Vol. 1, p 157)
- TRANSPORTATION AND HANDLING
- 16 Small items shall be restrained during transport. 131(Vol 1, p 215)
- 17 When necessary to transfer contents of storage container from one place to another, the container shall be usable as the transfer medium. 131(Vol 1, p 247)
- 18 Items being transported during a resupply mission shall be easily removable under 0-g conditions. 131(Vol 1, p 375)
- 19 **(Mass, configuration, and size of manually-handled items shall be compatible with TBD handling capability of EMU-suited crew members.)** 131(Vol 1, p 375)
- 20 Resupply items shall be transported in bulk containers which can be transferred into the Space Station intact. 131(Vol 1, p 375)
- 21 Logistics supply items requiring removal one at a time in a programmed sequence shall be oriented to allow for removal in the required sequence. 310(3-101)
- PRESERVATION, PACKING, AND PACKAGING
- 22 All components subject to removal/replacement, or which otherwise require ready identification by the crew, shall be clearly labeled. 131(Vol 1, p 92)
- 23 Spare parts shall be easy to remove from package/storage and packages shall be usable for stowage of used parts without extensive manipulation of packing material. 131(Vol 1, p 131)

- 24 Efficient and convenient means of opening packages, and for closing/sealing packages by EMU suit gloved hands, shall be provided. 1131(Vol 1, p 499)
- 25 **(Packaged items shall be in TBD forms, such as cubes or squares to save space.)** 128(p 60)
- 26 **(Provide TBD packaging for efficient handling of materials and small items (e.g., spares) in O-g environment.)** 172

CANDIDATE SOLUTIONSREFER. NO.

RESUPPLY

- 01 Perform detailed maintenance analysis of all operational flight hardware to identify necessary ORU's. Perform mission simulations to achieve confidence that types & quantities of defined ORU's will satisfy mission integrity requirements.
- 02 Perform Logistic Support Analyses (LSA) to depth necessary to define materials and quantities adequate for mission support between resupply events.
- 03 Provide spares in accordance with maintenance analyses/reliability estimates/risk considerations/on-board limitations. 1131(Vol.1, p 131)
- 04 Perform mission analyses and simulations to extent necessary for confidence in identification of resupply needs. 1124(p 3-13)
- 07 Stowage configuration can be documented quickly and effectively by use of photographs. 1172(p 25)
1102(p 50)

INVENTORY MANAGEMENT AND CONTROL

- 08 Review existing IMS and identify/analyze good and bad points. Structure Space Station IMS as amalgamation of best attributes. Accommodate information both resident onboard and available through up-link from ground. Include capability for video displays and voice recording of counseling specialists in real-time. 1172
- 09 In collaboration with current and designated astronauts, determine recommended format and publish instructions to assure common implementation among all contractors. 1172
- 10 Implement through Space Station program by Level B procedure. 1172
- 11 A systematic method of stowing ORU's and identifying their location should be devised, compatible with inclusion in the inventory 1131(Vol. 1, p 131)
1172

listing.

- | | | |
|----|--|--------------------|
| 12 | Spare parts nomenclature/serial and part numbers should be easy to read, located where they can be read both when stowed and when in use, and should be located where they will not be damaged during storage or access. | 131(Vol. 1, p 131) |
| 13 | Provide distinctive color/pattern coding and labeling of similar items, i.e., units whose differences are largely functional. | 131(Vol. 1, p 247) |
| 14 | Include "user-friendly" and changeability requirements in software specifications. | 172 |
| 15 | All flight units should have an easily traceable pedigree. | 172 |

TRANSPORTATION AND HANDLING

- | | | |
|----|---|----------------------|
| 16 | Provide see-through containers with simple, easy-to-use, closures for transporting small items. | 131(Vol 1, p 215) |
| 17 | Provide detachable containers with handles for contents that are to be transferred from one location to another as a group. | 131(Vol 1, p 215) |
| 18 | Provide containers of resupply items with simple-to-release tie-down devices. | 131(Vol 1, p 375)172 |
| 20 | Provide bulk packing of supplies such that packages can be exchanged with expended ones. | 131(Vol 1, p 375) |

PRESERVATION, PACKING, AND PACKAGING

- | | | |
|----|--|-------------------|
| 22 | Provide readable, descriptive labels for all components; e.g., wire harnesses, black boxes, ORU's, etc. - labels should use same terminology as documentation. | 131(Vol 1, p 92) |
| 23 | Provide molded reusable packaging of spare parts. Use as few pieces of packaging material as possible. | 131(Vol 1, p 131) |

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

552 MAN-TENDED

55215 RESTRAINT SYSTEMS

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4-49

Revised: 8/19/85REQUIREMENTSREFER. NO.

- | | |
|--|------------------|
| -01 Restraints shall be designed to not require muscular tension to remain in the restraint and not require conscious effort of an EMU crewmember to remain contained. | 105(p 9)
113 |
| -02 <i>*(The EMU foot restraints should be of TBD standardized design throughout the station.)*</i> | 105(p 15)
113 |
| -04 Foot restraints shall not interfere with EMU movements when not in use. | 132(C-4-49) |
| -05 Foot restraints shall facilitate EMU ingress/egress with out the use of hands. | |
| -06 <i>*(Foot restraints shall accommodate TBD EMU foot size range.)*</i> | 132(C-4-49) |
| -07 Foot restraints shall be easily repairable and/or replaceable. | |
| -08 The EMU foot restraint shall be positive & firmly hold the user in the desired position. | 113 |
| -09 The EMU foot restraint shall be capable of being engaged & disengaged easily & quickly. | 113 |
| -10 The EMU foot restraint shall permit the user to change position during use in order to allow full advantage to be taken of the 0-g envelope of operations. | 113 |
| -11 A portable form of the EMU foot restraint shall be available for installation at various temporary work sites within the Lab module. | 113 |
| -12 EMU foot restraints shall be adjustable to permit the specified crewmember range to perform manipulative tasks at chest level. | 138 |
| -13 <i>*(A TBD portable adjustable crew restraint</i> | 132(C-4-49) |

shall be provided that will facilitate EMU crewmembers positioning & stabilization at all potential work locations.)*

1124 (app C,
1B-1-34)

- | | |
|--|-------------|
| -14 Space Station structure shall be designed to accept or accommodate EMU portable restraints; foot and handholds. | 132(C-4-49) |
| -15 Items that require movement in the Lab module shall have built-in handles and/or structural or mechanical parts suitable for gripping with EMU gloved hands. | 132(C-4-48) |
| -16 Handholds/hand rails shall be strategically located to assist EMU entry/exit at all work stations. | 132(C-4-50) |

CANDIDATE SOLUTIONS

REFER. NO. _____

None

CRITICAL ASSUMPTIONS

REFER. NO.

- o The man-tended unpressurized station module will be replaced for manned IOC.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

552 MAN-TENDED

55216 MOBILITY AIDS

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4-50

Revised: 8/19/85REQUIREMENTSREFER. NO.

- 01 Installed or portable items in the station that require moving shall have built-in handles and/or structural or mechanical parts suitable for EMU gloved hand gripping, and shall have tether attach loops. | 132(C-4-50, 2.2.10.1.g.1 146
- 03 **(Provide TBD EMU crew translation aid systems for efficient handling of equipment & small parts during translation.)** | 132,138
- 06 Provide design features such as installation/handling devices on portable gear as needed that will facilitate EMU use. | 146
- 07 **(Dimensions and handling characteristics of mission payloads and resupply items to be handled by the flight crew must be designed to TBD dimensions and characteristics.)** | Crit Assumpt 6,7,9

CANDIDATE SOLUTIONSREFER. NO.

None |

CRITICAL ASSUMPTIONSREFER. NO.

- o The man-tended unpressurized station module will be replaced for manned IOC.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

552 MAN-TENDED

55217 COMMUNICATIONS

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.6)

Revised: 8/14/85

REQUIREMENTSREFER. NO.

- | | |
|--|-------------|
| -01 Provisions shall be made for voice communication between all points in and around the Space Station and between the station and orbiter crewmembers. | 131(p 427) |
| -02 Auditory feedback within the communication system shall be avoided. | 131(p 427) |
| -03 Communication shall be by voice to the maximum extent possible. | 131(p 427) |
| -04 EMU headsets shall be wireless, comfortable, and convenient. | 131(p 427) |
| -05 Crewmembers shall receive information without the need for monitoring the reception process. | 131(p 391) |
| -06 <i>*(All communication systems shall indicate operating status, receive or transmit and have TBD design for EMU suited control.)*</i> | 132(p 391) |
| -07 Communication system shall not be interlocking so that one switch can interfere with the whole system. | 132(p 391) |
| -08 Sufficient signal intensity and background contrast shall be provided to ensure clear communication. | 132(p 391) |
| -09 Provide a video means of presenting the following, including but not limited to: system diagrams, maintenance (type, quantity, storage location), procedures, diagrams/schematics, uplink of graphic data. | 131(p 423) |
| -10 Provide a means of recording and editing visual information. | 131(p 423) |
| -13 CCTV shall be provided. | 132(C-4-34) |
| -14 <i>*(The C&T design shall provide TBD for crew-</i> | 132(C-4-39) |

*members to communicate privately with the ground. The private communications link shall include both audio and video data.)**

- | | |
|---|-------------|
| -15 Provide uninhibited communication between Space Station personnel and ground control. | 131(p 431) |
| -18 The C&T design shall provide the capability to record audio and/or video. | 132(C-4-34) |
| -19 The C&T system shall provide storage and retrieval of TV and CCTV. | 132(C-4-34) |
| -20 Space Station personnel shall be able to record ground to space information transmission for later use. | 131(p 431) |
| -21 Provisions shall be made for a contingency command and telemetry link to the ground from the Space Station and Space Platforms. | 132(C-4-35) |
| -22 Provisions shall be made for visual communications between crewmembers inside and outside of the station. | 132(C-4-34) |
| -23 Provisions shall be made for light signals and hand signals between crewmembers. | 359 |

CANDIDATE SOLUTIONS

REFER. NO.

- | | |
|--|------------|
| 02 Provide a means of isolating speaker output from microphones. | 131(p 427) |
| 04 Provide lightweight, wireless headsets with low pressure, soft ear contact. Crewmember head movements should not displace headsets. | 131(p 427) |
| 05 Provide an on board "teletype" or other remotely controlled copying/recording device. | 131(p 391) |
| 06 Provide standardized displays controls, switches, etc. of specialized design for EMU accommodation. | 131(p 391) |
| 07 Provide clear and unambiguous functionally relevant labels for controls. | 131(p 391) |
| 06 Provide illuminated annunciation of transmit/receive status of communication system channels. | 131(p 391) |
| 07 Provide communication systems with independent subfunctions. | 131(p 391) |
| 08 Provide strong clear auditory signals per MIL-STD-1472. Provide sufficient lighting, size of indicator scales and pointers. | 131(p 391) |

- 10 Provide a video tape recorder capable of recording at rapid rates and compatible with on-board playback equipment. Provide video tape editing equipment. |131(p 423)
|
|
|

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

PRELIMINARY

552 MAN-TENDED

55218 QUALITY ASSURANCE

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.12)

Revised: 8/14/85REQUIREMENTSREFER. NO.

-01 The quality assurance tasks necessary during the man-tended phases of Space Station on-orbit operations shall be limited to procedure and condition verification, and then only to the extent that this can be accomplished visually as procedures are accomplished.

1313
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|CANDIDATE SOLUTIONSREFER. NO.

None

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|
|CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

553 MAN-TENDED

55301 CREW TRAINING

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-14(3.2.2.7)

Revised: 8/19/85REQUIREMENTSREFER. NO.

- | | |
|---|----------------------------|
| -01 <i>*(TBD concepts and procedures will be taught in the classroom via lecture and classroom aids.)*</i> | 124(p 7-1) |
| -02 Complex manual performance tasks will be taught on the ground using part-task trainers, flight hardware, in both 1-g and 0-g environments. | 131,125
(p 3-23) |
| -03 Critical procedures, to include emergency procedures, will be taught on the ground using part-task trainers and full team simulations. | 125(p 3-23)
132(C-4-33) |
| -04 <i>*(Provide TBD training which can be self-managed via interactive computer aided instruction or other technically advanced learning aids.)*</i> | 132,130
(p 180) |
| -05 <i>*(High fidelity TBD simulation and simulators are required to train critical tasks to some predetermined level of performance.)*</i> | 124 |
| -06 <i>*(Simulation and simulators [fidelity TBD] are required to train non-critical tasks to some predetermined level of performance on the ground and on-orbit.)*</i> | 132(C-3-11) |
| -07 Critical and non-critical tasks will be identified by task analyses early in the design phase. | 316 |
| -08 <i>*(Critical and non-critical tasks will be trained to a [TBD] performance criterion.)*</i> | 316 |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

o The man-tended unpressurized station module will be replaced for manned IOC.

o Payload-unique training will be provided by the customer.

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

553 MAN-TENDED

55303 MAINTAINABILITY

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: (See below)

Revised: 8/19/85REQUIREMENTSREFER. NO.

- | | |
|---|-----------------------|
| -01 The accessibility requirements shall meet the EMU accessibility envelope criteria. | 124 |
| -02 Subsystems equipment shall be removable or replaceable by using installation handling devices & standardized on-board EVA tool kits. | 317 |
| -03 The interconnecting plumbing & wire/cable access shall have EMU suitable attachment length & mounting characteristics to facilitate removal/replacement. | 317 |
| -04 <i>*(Service points for fluid systems, including those for filling, draining, purging or bleeding, shall be in TBD locations in EMU accessible locations.)*</i> | 318 |
| -06 <i>*(All payloads with seals, where integrity is required, shall be accessible by EMU TBD design concepts for inspection, maintenance or repair as required.)*</i> | 132(C-4-19, 2.1.11.2) |
| -07 Where mechanical fluid connectors are required, sufficient clearance/access shall be provided to allow for EMU installation of new connectors if damage occurs. | 124(C-I-15, #42) |
| -08 EMU accessibility to equipment attaching hardware, electrical connectors, electrical breakers/fuses, and plumbing shall be provided in all areas, without the need to remove the ORU. | 124(C-I-15, #34) |
| -09 No connector shall be lockwired. | 124(C-I-15, #38) |
| -10 Wire harness & fluid lines shall be in cable trays for ready access. | 124(C-I-13, #6) |
| -11 Fold out drawers & cabinets shall be used where possible to provide ease of EMU access, | 124(C-I-13, #5) |

and panels shall be designed to be looked at from different angles.	
-12 Fluid & gas connector shall be located & configured so they can be inspected.	124(C-I-13, #7)
-13 Provision shall exist for EMU crew accessibility to automated functions via high-order language & audit trails.	124
-14 The largest removable item which is inside the Space Station shall be sized to allow EMU removal from the station.	124(C-I-13, #10)
-15 The Orbital Replaceable Hardware (ORUs) shall be designed for ease of EMU on-orbit replacement. The hardware shall be designed or integrated to use common type fasteners, common connectors & common EVA tools, and to use the same packaging as appropriate. In addition, all connections shall be designed & labeled to preclude improper mating.	321(p 26)
-16 Standardized EVA maintenance tool kits & maintenance aids shall be provided for work in a depressurized module.	124
-17 Commonality requirements for EMU accommodatable or adaptable hardware/software interfaces, attaching hardware fasteners, bolts, etc., shall be implemented and controlled to ensure supportability, interchangeability, and maintainability.	321
-18 Wherever practical, systems shall be designed such that repair can be accomplished by removal/replacement of subsystems or components.	124(C-I-16, #50)
-20 Generic repair capabilities shall be developed.	124
-21 All connectors shall be curved & with a surface texture designed to prevent EMU glove damage.	124
-23 The ORU design and configuration shall accommodate the EMU work envelope & mobility range in the man-tended, depressurized module.	Crit Assumpt 6,7,9

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- o Designed such that maintenance does not introduce hazardous or destructive conditions.
 - o Designed to provide adequate EMU clearance & accessibility to facilitate maintenance.
 - o The man-tended unpressurized station module will be replaced for manned IOC.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

553 MAN-TENDED

55304 MAINTENANCE

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: (See below)

Revised: 8/19/85REQUIREMENTSREFER. NO.

- 01 The man-tended station maintenance concept shall represent an approach to on-orbit maintenance that satisfies the requirement for a station life of five years. | 132(C-14,
| 3.2.2.7)
- 02 **(The TBD maintenance concept shall define the ORU levels and maintenance activities, as differentiated from normal man-tending functions.)** | 328
| Crit Assumpt
| 6,7,9
- 03 **(TBD maintenance activities shall be performed at TBD locations/workstations within the station module and/or the STS.)** | 124(3.1.6,
| 3-13)
- 04 **(The maintenance workstation shall be provided per TBD design requirements.)** | 132(C-14,
| 3.2.2.7)
| 124(4.2.3,
| 4-10)

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- c The man-tended unpressurized station module will be replaced for manned IOC.

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

PRELIMINARY

553 MAN-TENDED

55305 SUPPORT EQUIPMENT

CROSS REFERENCE TO RFP PARAGRAPH No: C-4-49

Revised: 8/19/85REQUIREMENTSREFER. NO.

- | | |
|--|------------------------------|
| -01 Common attachment designs and tools shall be provided for EMU-suited use. | 329 |
| -02 Temporary restraint of equipment shall be available near stowage areas and removable equipment areas throughout the module and will accommodate EMU handling requirements. | 132(C-4-49,
 pp 2.2.10.1) |
| -03 Tools shall be stored in areas which correspond to their functional application and be easily accessible to an EMU crewmember for maintenance/repair. | 116 |

CANDIDATE SOLUTIONSREFER. NO.

None

CRITICAL ASSUMPTIONSREFER. NO.

- o The man-tended unpressurized station module will be replaced for manned IOC.
- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

553 MAN-TENDED

PRELIMINARY

55306 ACTIVITY PLANNING AND SCHEDULING

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.11)

Revised: 8/14/85REQUIREMENTSREFER. NO.

DUTY CYCLES

- | | |
|--|-----------------------------|
| -01 <i>*(Time lines and learning curves for different types of space operational tasks with different types of equipment in the EVA modes shall be TBD. Include the use of teleoperations, robotics, etc. Set standard time lines for given tasks - TBD.)*</i> | 128(p 89, 97-98) |
| -02 <i>*(The standard duty time for payload activities, and station upkeep per day and per week is TBD.)*</i> | 128(p 89-100) |
| -03 Time shall be provided in crew schedules for the following activities: exercise, meals, recreation, rest, and sleep periods. | 128(p 89-100) |
| -04 Mission length shall be set prior to flight & adhered to with extensions being added only after consultation with the flight crews. | 129(p 50) |
| -07 <i>*(Sleep periods shall include pre and post sleep periods TBD.)*</i> | 128(p 96) |
| -08 Crews shall have time for preparation before and clean-up after major tasks. | 131(p 146) |
| -11 Physiological cycles and the factors/conditions that adversely affect them shall be considered in designing activities of crew. | 131(p 163) |
| -12 Crew activities shall be designed to facilitate performance and to minimize fatigue. | 128(p 89-100), 384(p 45-47) |
| -13 <i>*(The first TBD days of workload shall be light with individual needs taken into account.)*</i> | 131(p 164) |
| -15 The possibility for short rest breaks during the day shall be included. | 130(p 152-153) |

- 18 There shall be overlapping of shifts for transition orientation if 24-hour manning shifts are required. 128(p 94)
131(p 154)
- 19 **(The maximum length for beginning missions shall be TBD.)** 131(p 163)
- 20 Scheduling systems shall provide for flexibility in task time allotments, job assignments & accommodation for the unexpected. Allowance for changes in routine shall be made. 128,330
- 21 **(The maximum amount of EVA that a crewmember can effectively carry out on a daily & weekly basis shall be TBD.)** 128(p 90-91)
385(p 72,79)
- 22 **(The maximum amount of time required to maintain space suits per EVA shall be TBD.)** 128(p 90-91)
- 23 **(The maximum number of STS crew required during EVA shall be TBD.)** 385(p 72-79)
- 24 **(The optimal amount of time which can be anticipated for EVA on a routine basis shall be TBD.)** 385(p 72-79)
- 26 **(Various schedule models for optimal crew effectiveness over mission duration shall be TBD.)** 128(p 89-100)
- 27 **(Conditions which are conducive to error relative to different types and sequences of tasks, breaks, etc. shall be TBD.)** 386
- 28 **(Minimal amount of exercise and rest time required to maintain proper health, motivation & alertness for different types of people over different mission lengths shall be TBD.)** 128(p 140-143)
- 29 **(Factors related to crew productivity that are related to different scheduling patterns, different mission requirements, crew, skill mix, task pattern and mix, and mission length are TBD.)** 128(p 89-100), 384(p 45-47)
- 30 **(The frequency and length of rest breaks as they are related to productivity shall be TBD.)** 128(p 92-93)
- 32 **(The amount of time for refresher or training prior to various tasks and relative to the frequency of task performance shall be TBD.)** 128(p 111-112)
- 33 **(The most time-effective training methods shall be TBD.)** 128(p 111-112)
- 34 **(The effects of the use of shifts on alertness fatigue and error rates shall be TBD.)** 128(p 94),
384(p 45-47)

*This includes circadian interference as well as loss of sleep due to the activities of awake crewmembers.)**

- 35 Work/rest cycles shall retain earth circadian rhythm cycles to the maximum extent possible. 131
- 36 Allow for personal needs, private time, grooming, etc. in work shift scheduling. 131
- JOB ROTATION
- 37 Flight crews shall have cross training and back-up skills to enable job rotation and back-up. 131(p 160)
130(p 201)
129(p 54),
128,130(p 148, 151)
- 38 **(The important & essential crew requirements which all crewmembers should have shall be TED.)** 128(p 97-100)

CANDIDATE SOLUTIONS

REFER. NO.

- GEN Provide recommended work/rest program periods, but allow crews to make day-to-day decisions. Identify sequences and lengths of tasks insofar as they are related to error rates and fatigue in order to recommend the optimal times to use in scheduling various kinds of tasks. 131(p 143)
128(p 89)
- GEN Provide normal 24-hour schedules. 131(p 146)
- GEN Schedule every crewmember for routine duties.
- GEN Provide computer scheduling programs.
- 07 Provide same sleep hours for all crewmembers. 131(p 154)
130(p 154)
128(p 94)
195(p 104)
- 07 Schedule a 9-hour period of uninterrupted sleep per day, per person: 8 hours sleep and 1/2 hour prior and post sleep.
- 11 If shift work is necessary, crew members should phase into it prior to mission. Provide mathematical analysis of the heart rhythm to determine early signs of fatigue. 131(p 163)
130(p 164)
- 13 Allow several days to get station in working order and to set up scientific equipment. 131(p 164)
130(p 150)
- 15 Provide facilities and ability for short rest breaks. 130(p 152-153)
- 20 Allow crew to reschedule when overloaded, 131(p 160)

- fatigued, or adapting to environment. Provide job rotation. 130(p 146-152), 128(p 96-100)
- 37 Provide for familiarity by crew of each other's specialties but not necessarily expertise. Provide varied duties within job rotations. 131(p 160)
- 37 Provide larger training base for smaller crews.

CRITICAL ASSUMPTIONSREFER. NO.

None

- * An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

553 MAN-TENDED

55307 MAN-MACHINE ROLES

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.7; 2.1.11)

Revised: 8/15/85REQUIREMENTSREFER. NO.

- | | |
|---|---|
| -01 Provide automation or autonomous control to achieve an optimal mix of human and machine resources and substitute "machine control" for human control where safety, productivity and cost effectiveness warrant. | 1331(p 5-4)
132(C-3-14)
135 |
| -02 Continuous system/subsystem monitoring and control by either the flight or ground crews shall not be required for normal Space Station system operations. | 132(p 21-22) |
| -03 Space Station systems/subsystems shall be designed such that any single credible failure will result in a safe condition. Subsequent crew action may be required to restore normal Space Station system operations. | 132(p 21-22) |
| -05 The capability for the crew to status and monitor all subsystem health and status data shall be provided. | 132(C-4-21) |
| -06 The flight crew shall be able to change automated sequences and limits in real time and on line. | 132(p 21-22) |
| -07 Appropriate safeguards shall be provided to prevent inadvertant or unauthorized disabling of essential automated processes. | 1331(p 5-4) |
| -08 System/subsystem verification shall be performed with a minimum of crew interaction and shall be capable of being initiated automatically or manually. | 133(p 4-1,
5-6);331
(p 5-4);131
(C-3-14) |
| -10 Automated fault detection, isolation, and recovery shall give highest priority to crew life support and primary mission objectives. | 1331(p 5-4) |
| -11 The crew shall be able to override any automatic safing or switchover capability of functional paths. All overrides shall be two- | 132(C-4-21)
132(C-3-14)
1331(p 5-4) |

- step operations with positive feedback to the initiator that reports the impending results of the override command prior to the acceptance of an execute command. Separable functional paths shall be used to prevent single failures from causing both an unintended auto switchover and the inability to override it.
- 12 All automated systems shall provide easily accessible, complete "audit trails" for actions taken. 133(p 5.6)
 - 13 Only processed results will routinely progress upward through the hierarchy. Lower level data will be accessible at higher levels when required. 331(p 5-4)
 - 14 The growth of the SSP capability shall accommodate increased levels of autonomy and automation/robotics. 132(C-4-9)
 - 15 Review the recommendations of the Advanced Technology Advisory Committee (ATAC) and utilize automation and robotics at each proposed step of evolutionary growth of the Space Station in such a way as to attain the most productive man/machine mix and simultaneously, to identify the Space Station systems that represent the most promising opportunities for the advancement of automation technology both in space and on the ground. 132(C-3-14)
 - 16 A phased progressive automation of both flight and ground elements shall be accommodated consistent with evolving system requirements, cost, applicable technologies, and the NASA Automation and Robotics Plan. 132(C-4-16)
 - 17 **(The degree of automation & design of crew interfacing control equipment shall be TBD.)** 132;Crit. Assump 3,5,7

CANDIDATE SOLUTIONS

REFER. NO.

- GEN Develop a decision guide to be used to logically allocate space activities to alternative man-machine implementation modes based on the criteria of performance, cost and technical readiness. This decision guide should be a dynamic model which can accept updated information based upon changes in human and hardware performance (mainly hardware/software) and changes in confidence factors in human or equipment performance. 135(p 3.0, p 3.1-3.29) 133(p 9)
- GEN Establish a single point of contact for processing advisories, suggestions or proposals which are offered to assist in achieving the

objective of the man-machine roles in the
Space Station program. This focal point
should act as a receptive ear for all data
sources that can contribute to the effective-
ness of the overall design, i.e., designers,
analysts, ground crew, simulation instructors,
contractors/vendors, crewmembers, training
specialists, etc.

CRITICAL ASSUMPTIONSREFER. NO.

None

- * *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

553 MAN-TENDED

55309 STATION AUTONOMY

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.1.7)

Revised: 8/15/85

REQUIREMENTSREFER. NO.

- 01 **(Untended periods may require significantly fewer functions to be maintained for purposes of sustaining the Space Station. Only TBD station functions need to be automated in the untended and in the tended modes of operation.)** | 334(3.2.1)
- 02 **(TBD functions and/or elements of the man tended station shall be capable of being externally controlled.)** | 332(P5-4)

CANDIDATE SOLUTIONSREFER. NO.

None |

CRITICAL ASSUMPTIONSREFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.

5 IVA/EVA INTERFACE

553 MAN-TENDED

55310 COMPUTER MODELING

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-6(3.0)

Revised: 8/15/85REQUIREMENTSREFER. NO.

ANTHROPOMETRIC COMPUTER MODELING

-01 General Requirements

336

- a) The man-model shall be capable of full integration with the daily activities of the Phase B, C/D design group.
- b) If a tradeoff must be made, pictorial detail shall have a lower priority than analytical utility in choosing man-model systems for Space Station applications.
- c) The man-model shall substantially reduce the requirement for human engineering design inputs to be transmitted in the form of hand drawn sketches.
- d) The man-model shall substantially reduce the requirement for using 2-D drawing board manikin for workstation and manned area design.
- e) The man-model shall be capable of portraying the human figure in the EMU 0-g posture.
- f) The man-model shall be directly responsible for a reduction of the costs associated with 3-D model, mockup and simulator design, construction and utilization.
- g) The man-model shall be capable of effectively demonstrating that the man-machine interface has been properly and safely resolved.
- h) The man-model shall be of a quality which is adequate for serving as a surrogate test subject.
- i) The man-model shall contribute to the generation of common interpretations of anthropometric assumptions between design personnel.
- j) The man-model shall be of graphic quality suitable for display to customers, management, and the press.

-02 Analytical Requirements

336

- a) In the early layout phases of the Space Station design; the man-model shall be capable of use as an interactive design tool.
- b) For every area of the man-tended Space Station

- the man-model shall be capable of being super-imposed in various concepts and configurations to assess the general "fit" and scale of the system.
- c) The man-model shall be capable of supporting decisions relative to accesses & general station configurations.
 - d) The man-model shall provide quick, credible, presentable reach information.
 - e) Individual human figures shall be capable of portrayal in various body orientations interacting with equipment.
 - f) The control contact or shortfalls of individuals shall be demonstrable and quantifiable.
 - g) Crewmembers' relationships to objects which interfere with their ability to reach controls shall be demonstrable.
 - h) The ability to generate reach envelopes is a requirement.
 - i) Illustration of the effects of EMU garments, acceleration, and partial gravity on crewmembers' reach capability is required.
 - j) The ability to sequentially reposition or animate the human figure as it progresses through an area, negotiating turns, obstacles, and other crewmembers is required.
 - k) The handling of objects and tools during operations requires a capability in the man-model for multiple moving elements (limbs, torso, etc.) and the attachment of elements to the human figure (e.g., at the gloved hands).
 - l) Because of 0-g, 3-D rotation of the man-model & movable viewing points are required in the evaluation of crewmember mobility.
 - m) The man-model shall contribute to the design and planning for a variety of crew tasks for EMU-suited crewmembers.
 - n) The capability for showing multiple human figures and their simultaneous interaction with a task is a requirement.
 - o) The man-model shall contribute to the solution of control operability problems.
 - p) The man-model shall be capable of interfacing with the 3-D geometric data base such that lines of sight from the ERP (Eye Reference Point) of the crewmember to displays can be graphically depicted.
 - q) Quantities such as visual linear distance and reference angles shall be accessible from the model.
 - r) Visual obstructions shall be identifiable from the model display.
 - s) The man-model shall be capable of contributing to the design of 0-g body restraints.
 - t) The man-model shall be capable of the integrated assessment of body strength capability for EMU-suited crewmember.
 - u) The man-model shall contain accurate linear and angular dimensions and the capability of

- computing and resolving individual joint torques through the EMU-suited body.
- v) The man-model shall be capable of indicating if, for the given body orientation, the muscles can generate the force required to overcome the control resistance. If not, the man-model shall iterate through successive body orientations until one is found in which the control can be operated or it is decided that the control resistance characteristics must be modified.
 - w) The man-model shall be capable of contributing to the analysis of the force required to perform tasks while wearing candidate spacesuits.
 - x) The strength assessment capability of the man-model requires internal kinematics algorithms and the ability to compare previously input survey-based strength data with force levels generated by the man-model for the task under study.
 - y) The man-model shall be capable of use in workstation procedures development and evaluation activities.

CANDIDATE SOLUTIONSREFER. NO.

See Subelement 55310A

CRITICAL ASSUMPTIONSREFER. NO.

See Subelement 55310A

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

553 MAN-TENDED

55310A COMPUTER MODELING

PRELIMINARYREQUIREMENTSREFER. NO.-03 Anthropometric Requirements

336

- a) The man-model shall be based on a central skeletal figure.
- b) The man-model shall include means for automatically generating random link lengths for human figures of a given reference dimension (usually stature).
- c) The man-model shall have the capability of automatically accepting large quantities of empirically collected human dimensional data.
- d) The man-model shall have the capability of generating figures which are composed of both randomly generated links and user specified link lengths.
- e) The man-model shall have the capability of accepting data, transforming data, and generating figures of male and female subject populations.
- f) The man-model shall have the capability of automatically rectifying the input survey data for future growth trends.
- g) The man-model shall have the capability of generating figures which have been defined in terms of either percentiles or regression equations.
- h) The man-model shall incorporate equations which transform external anthropometric data (which have been input from survey data) into internal link lengths for use in drawing human figure skeletons.
- i) The ranges and centers of motion of the man-model's joints shall be selectable by the user.
- j) The man-model shall include the capability for generating human figures from a variety of anthropometric data surveys.
- k) All dimensions of the figures generated by the man-model, whether taken from empirical data or estimated, shall be documented and traceable to their origins.

-04 User Interactiveness Requirements

336

- a) The man-model shall be capable of efficiently performing all of its required functions while

- being operated by design engineering and other technical personnel.
- b) Special training required to attain proficiency with the man-model shall be minimized.
 - c) The hardware required to implement the man-model shall reside in the engineering office area with the goal being a desktop system for all appropriate personnel.
 - d) The software for the man-model shall be written in a top-down format with a menu page as the first display of every level of detail.
 - e) The software for the man-model shall be written with self-tutorial and "help" sections which can be suppressed for rapid operation by experienced users.
 - f) The software for the man-model shall be written such that operator errors are identified and explained to the operator.
 - g) Where possible, the software shall be capable of automatically resolving operator errors with no degradation of model performance or unnecessary error annunciation.
 - h) Interaction with the computer model shall maximize the use of English commands.
 - i) The English commands which are used shall be simple, universally-understood terms.
 - j) The system shall be operable by persons with no knowledge of computer jargon.
 - k) The man-model shall be supported by written documentation which is concise and clear.
 - l) Sequences of steps, menus and other references shall be included in the written documentation.
 - m) A table of contents, glossary and index shall be included in the written documentation.
 - n) Operational instructions in the written documentation shall be maximized.
 - o) Theory and code in the written documentation shall be limited to only that which is essential for proper system operation.
 - p) Operation of the man-model shall require a minimum of memorized terms and procedures.
 - q) Complex procedures shall be accomplishable by use of prompts, tutorials, and diagnostics.
 - r) Input device operation shall either be explained in the software or be self-evident.
 - s) The system shall include means for constantly apprising operators of their current location in a complex sequence of steps or procedures.
 - t) Changes and deletions of commands & displayed graphic features shall be straightforward and logical.
 - u) The system shall be forgiving of user errors in commands and graphic inputs.
 - v) Real-time simulation capability is required for instantaneous evaluation of the interfaces between the computer generated human figure and its associated hardware.
 - w) The man-model's geometric data base shall

- include sufficient points to describe the work station or task area, but shall efficiently utilize storage space.
- x) The data management characteristics of the selected CAD system shall be utilized for geometric data base operations.
 - y) In the man-model, the required population parameters for a variety of appropriate populations shall be internal to the software such that the operator specifies the figures desired to be synthesized by keying in responses to software-generated questions.
 - z) For initial man-model operation, the ability to choose between 0-g and 1-g is required.
 - aa) As more data concerning the effects of partial gravity on posture are generated, the man-model shall be upgraded to allow the choice of partial gravity conditions.
 - bb) The man-model shall utilize a straight-forward scheme for the quantification of body configurations.
 - cc) Initial body configurations shall be (1) key specifiable by using the configuration quantification scheme, or (2) control device specifiable by using a device such as a track ball or mouse.
 - ee) The man-model is required to generate appropriately sized figures in response to user's input early in the interactive session.
 - gg) The EVA condition shall impose the mobility, strength, and vision restrictions which most accurately represent the Space Station EVA suit or developmental versions thereof.
 - hh) The graphic depiction of the figure shall also change in response to garment inputs (the suit shall be superimposed over the basic figure).
 - ii) Operator inputs which shall be required are:
 - o Geometric data base for the hardware associated with the task under study.
 - o Restraint positions for the exertion under study.
 - o Anthropometric assumptions such as grip type, exertion type (dynamic or static), etc.
 - o Empirical survey data indicating maximum force producible by humans of given size percentiles and for given exertions.

-05 Display Requirements

- a) For purposes of coding, simplification of complex assemblies and realism, color capability is a requirement.
- b) All forms shall be rendered as solids with external surfaces rather than the wire frame transparent techniques.
- c) The ability to vary the transparency of the man-model's surface when viewing visually blocked structure or the figure's internal skeleton is required.
- d) The capability to indicate visually blocked

336

structure with hidden (dashed) lines is required for cases in which semi-transparency is not desirable.

- e) The man-model shall have means to vary the brightness of its external surfaces as a function of the light intensity on those surfaces.
- f) These gradations of brightness shall vary smoothly as surfaces change orientation relative to the light source.
- g) The capability for changing light source locations and number is required.
- h) The ability to cast shadows from objects onto the human figure and vice-versa is required.
- i) Shadows shall be variable according to the position and number of light sources.
- j) Shadows shall have smooth, sharp demarcation lines and be of variable darkness in proportion to general ambient illumination levels.
- k) The realistic rendition of surface textures is a requirement.
- l) The capability to pre-plan and smoothly sequence a series of man-hardware orientations is required.
- m) The man-model shall be capable of displaying all of the required human figure and geometric data plus any reference points or symbols which may be required to enhance analysis effectiveness.
- n) These points shall be superimposed on the human figure and its associated geometry.
- o) The points will be designated by symbols and short labels such as ERP (Eye Reference Point).
- p) The man-model shall have the capability of being printed or plotted on hardcopy in a variety of sizes which are appropriate for the individual task under study.
- q) Visual lines-of-sight shall be easily distinguishable from lines in the display depicting geometry.
- r) The man-model shall have the capability of generating and displaying reference dimension lines for the purpose of increased clarity of analytical significance.
- s) Dimension lines shall be easily distinguishable from hardware geometry lines, the human figure and lines-of-sight.
- t) Dimension lines shall consist of arrowheads, lines and numerical dimensions.
- u) The man-model shall have the capability of generating and displaying a selection of garments superimposed on the human figure.
- v) The man-model shall have the capability of detecting and displaying in a clear, straightforward manner, any physical interferences between the human figure and its surrounding hardware.
- w) The man-model shall have the capability of

- full three-axis rotation of the visual display.
- x) The capability to locally increase and decrease the scale of the displayed figure and hardware is required.
 - y) The man-model shall have the the capability of drawing contours on the human figure which depict its intersection with and the intensity of radiation and fluids.
 - z) The man-model shall have the capability of displaying results of strength analyses.
 - aa) The man-model shall have the capability of displaying the anthropometric assumptions and initial conditions for each analytical session. This display shall selectably be in a prominent position on all graphic output formats.
- 06 System Compatibility Requirements 336
- a) The man-model shall be fully integratable with whatever CAD system is adopted as standard by the engineering organization.
 - b) The geometric data base upon which the human figure is superimposed shall be the CAD data base.
 - c) The input/output devices of the man-model shall be those used in the CAD system.
 - d) Any auxiliary devices, such as those required for real time analyses, shall be capable of handling the CAD data base.
 - e) Any integration of an external strength sub-routine with the man-model shall yield a final product which operationally and visually functions as a single package.
 - f) The man-model data base shall transfer to all hardware peripherals.
 - g) The hard-copy output shall be compatible with existing drawing standards.
- 07 **(A TBD biomechanical model shall be utilized for anthropometric analysis.)** 336

WORKLOAD MODELING

- 08 **(The TBD zero-g workload model should be utilized.)** 132(C-4-47)
- 09 The workload model shall address the following areas: 132(C-4-47)
- a) Error analysis/operating strategy/decision-making emphasis determination.
 - b) Task vs. "mental" workload emphasis determination.
 - c) Subjective techniques emphasis determination.
 - d) Control dynamics modeling emphasis determination.
 - e) Temporal emphasis of workload assessment: Predictive vs evaluative tools.

PHYSIOLOGICAL MODELING

-10 **(Physiological modeling requirements are TBD.)** | 132

CANDIDATE SOLUTIONS

REFER. NO.

03 Anthropometry

- c) The requirement for the man-model's accepting large quantities of empirical human dimension data would be satisfied by a system for digitizing dimensions directly from human subjects and automatically entering the data into the man-model's data base.
- f) The requirement for the man-model's automatically rectifying population survey input data for future growth trends could be achieved by incorporation of the appropriate linear regressions in the model software.

04 User Interactiveness

- aa) A long-term design goal should be to include algorithms for other types of postural deviations such as those caused by acceleration and handicaps.
- bb) A satisfactory scheme for the quantification of joint configurations should be developed.
- hh) Joint mobility changes should be specified.

05 Display

- b) If true solid modeling cannot be achieved, a simulated skin generated by a very dense wire-frame shall be considered.

CRITICAL ASSUMPTIONS

REFER. NO.

- o Computerized anthropometric man modeling is required for Space Station manned and man-tended systems design. 336,337,338
339

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

5 IVA/EVA INTERFACE

554 MAN-TENDED

55401 WORKSTATIONS

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.10.2)

Revised: 8/15/85REQUIREMENTSREFER. NO.

WORKSTATION DEFINITION

- 01 A crew station shall be defined as any location in the Space Station where a dedicated task or activity is performed. The following areas are workstations: consoles, EVA worksites, general laboratory, plant laboratory, materials science laboratories, animal laboratory, remote manipulator system control console, communication/data management consoles, and maintenance locations. 132(C-4-54)
- 02 A thorough analysis of the requirements shall be done for each workstation to determine the task, operator activities, level of automation tools, equipment, etc., necessary to meet the requirements. 132(C-4-54)
- 03 Each workstation shall meet the baseline safety requirements for the Space Station and will provide utility power. 132(C-4-54)
- 04 Workstations equipped to perform identical tasks (e.g., station housekeeping functions) shall utilize prime/backup logic with appropriate safeguards against dual functional path commanding. 132(C-4-54)
- 05 Work stations shall satisfy the fail-safe criteria. 132(C-4-54)

WORKSTATION GENERAL REQUIREMENTS

(NOTES: 1) Until the results of the pending study, 159,381 Man-Systems Integration Standards (JSC RFP 9BE3-6-4-45P), have been finalized, it is recommended that, in conjunction with the requirements given in this subelement, reference 159 and JSC-07387B, "Crew Station Specifications", be used for design. Reference 381 should also be used as a secondary reference.)

-06 Layout

- a. Workstations shall be laid out by first considering the EMU-suited operator's needs, capabilities and range of physical dimensions and then designing workstation hardware to accommodate these requirements. 159(pp 4.4)
 - b. Workstations shall be laid out in such a way that operator body motion required to perform all workstation functions shall be minimized. 159(pp 4.4)
 - c. Workstations shall be designed such that all external distracting stimuli to the operator are minimized. 159(pp 4.4)
 - e. Workstations shall be designed for 0-g body posture. 131(p 13)
 - f. Workstations should be located to minimize interference from traffic areas. 131(p 13)
 - g. **(The workstations shall accommodate TBD EMU-suited crewmember reach criteria.)** 159(pp 4.7)
- 07 Vision
- a. **(All workstations shall be designed assuming operation from a single TBD Eye Reference Point for each body location area required by the station's function.)** 159(pp 5.2.1.4, 5.1.2.3.3)
 - b. **(All visual displays shall be viewable from any angle less than or equal to TBD degrees from a line normal to and located at the center of the display.)** 159(pp 5.2.1.4)
 - c. **(Legibility characteristics of all workstations shall conform to TBD requirements. The readability characteristics of all workstations shall conform to TBD.)** 159(pp 5.5)
 - d. **(Clearances - The structural clearances required for adequate crewmember mobility are TBD.)** 159(pp 4.4)
- 08 Controls
- a. **(The configuration of controls, including their shape and basic mode of operation shall conform to TBD requirements.)** 159(pp 5.4)
 - b. **(The motion of controls, including their direction, stimulus/response compatibility and population stereotype characteristics shall conform to TBD requirements.)** 159(pp 5.4)
 - c. **(The feedback characteristics of controls, including their force/displacement curves, shall conform to TBD requirements.)** 159(pp 5.4)
 - d. **(The general coding characteristics of control (shape, color, texture, etc.) shall conform to TBD requirements.)** 159(pp 5.4)
 - e. **(Control configurations shall be standardized according to their intended use per TBD requirements.)** 159(pp 5.4)
 - f. Allow for crew intervention via computer displays and controls or via manual control valves, switches, circuit breakers, etc. Provide feedback of system status including the reflection of the actual state of the system and the effects of crew intervention via manual controls. 131(p 397)

-09 Displays

- a. **(The audio characteristics of electronic displays such as speech synthesis and caution/warning system aural shall conform to TBD requirements.)** 159(pp 5.3)
- b. **(The visual characteristics inherent to electronic displays such as CRT's, LCD's, EL, and LED's shall conform to TBD requirements.)** 159(pp 5.2.6
These characteristics include parameters such as brightness, flicker, focus, contrast, aliasing, typefaces, color separation, etc.)*
- c. **(Other human interface characteristics inherent to electronic display (e.g., tactile displays) shall conform to requirements.)** 159(pp 5.2.6
- d. **(Color standards shall be emplaced for non-electronic displays per TBD recommendations.)** 159(pp 5.2.2.2.2.)
- e. **(A TBD typeface standardization system shall be adopted for non-electronic displays.)** 159(pp 5.5)
- f. Displays shall provide a graphic readout of data rather than lists of numbers, etc. 131(p 410)
- g. Display information shall be limited to operationally relevant data, with access to "need-to-know" available. 131(p 410)
- h. Caution and warning information shall be presented graphically, unambiguously identifying the actual problem. 131(p 410)
- i. Displays shall be standardized between systems and levels within systems. 131(p 410)

- 10 Workstation provisions: standardization of workstation equipment shall be maximized. All workstations shall include the following common provisions configured for an EMU-suited crewmember: lighting controls, book/checklist holders, body restraints, integral lighting, pencil holders, means for confirming body positioning to ERP (Eye Reference Point), small checklist light, means of holding books/checklists to a specific page. 131(p 47)

- 11 Adjacent workstation with different "up" orientations (as determined by alphanumeric labeling) shall be avoided. 159(pp 4.4.g)

WORKSTATION UNIQUE REQUIREMENTS

- 12 Window Workstations 132(C-4-54);
For the EMU-suited crewmembers, all workstations associated with windows for operations & scientific research shall have provisions for the following items where dictated by the requirements analysis: camera mounts, small light, checklist body restraints, display & keyboard, moving map display with an optical device to view the flight path, orbital maps to identify future flight paths, method of measuring angles & the horizon if appropriate, control of adjacent lighting, easily deployed hood or curtain to block 131(p 1.2.1)

interior light.

-13 General Laboratories

- a. A general laboratory and workstation shall be provided with facilities for the following: inflight maintenance and repair, failure analysis, medical uses and studies, science (general physics experiments, materials processing, biology research, earth observations). 131(p 1.2.3)
- f. Laboratories involving attitude control shall provide for the control of small pointing maneuvers. 131(p 1.2.3)

-14 Plant Laboratories - The plant growth facility shall enable personnel involvement. 131(p 1.2.8)

-15 Observatory 131(p 1.2.6)

- a. **(Where required by the mission, an onboard observatory shall have TBD provisions.)**
- b. **(Capability for unrestricted viewing of both dark and sunlit sides of earth shall be provided.)** 131(p 1.2.6)
- c. **(A central viewing facility shall provide the following capabilities: Manual or automatic pointing, automatic tracking of a selected feature, e.g., directly below or off-track, dynamic (moving map) display depicting area (specified or being viewed) in perspective, variable magnification of field of view, time delayed video stereopsis of observations, HUD of imaging/data, instrument configuration, operational parameters, etc., time tagging of verbal comments/data, film/video recording of active viewing sequences.)** 131(p 1.2.6)
- d. **(Imaging/data instruments to record and present data should be provided as follows: real time image repeater (monitor) in the viewing facility (operator can see what the instrument is seeing or can see a coded/decoded/reconstructed equivalent), variable color coding for the image-feed selective capability to exhibit superimposed image combinations of the above.)** 131(p 1.2.6)
- e. **(The capability to use the following references shall be provided: hard copy or video of earth wide seasonal coloration, hard copy or videomaps with regional description, reference atlases (hard copy or video).)** 131(p 1.2.6)

-16 **(The design of the Mobile Remote Manipulator System workstation shall be per TPD requirements.)** 132(C-4-26, C-4-54)

PORTABLE EVA WORKSTATION

- 17 Each portable EVA workstation shall have a multifunction alphanumeric keyboard. 132(C-4-48) 133(p 453)

- 18 Each portable workstation shall be capable of 132(C-1-16)

interfacing with primary fixed workstations
and with the management communications and
data systems. |133(p 453)

-19 Each portable workstation shall incorporate
a restraint system for securing the device at
the using location. |133(p 115)

CANDIDATE SOLUTIONS

REFER. NO.

15 Provide gimbaled observation bubble with
small telescope with pointing capability.

CRITICAL ASSUMPTIONS

REFER. NO.

None

* An "ISSUE" has been defined for study to confirm or complete
definition of this preliminary requirement.

5 IVA/EVA INTERFACE

554 MAN-TENDED

55402 DATA MANAGEMENT

PRELIMINARY

CROSS REFERENCE TO RFP PARAGRAPH No: C-4(2.2.5)

Revised: 8/15/85REQUIREMENTSREFER. NO.

GENERAL DATA MANAGEMENT REQUIREMENTS

- | | |
|--|-------------|
| -01 A Data Management System (DMS) will provide the convenient and effective storage, exchange, manipulation, and retrieval of data by all appropriate station subsystems and users. | 133(p 455) |
| -02 <i>*(The operational interface to the DMS shall be through Multipurpose Applications Consoles (MPAC) and dedicated controls on data management hardware or TBD.)*</i> | 132(C-4-31) |
| -03 The initial DMS shall: a) support data base access, command and control, data transmission, computer, and workstation resources for the DMS users and station subsystems; b) enable DMS users and subsystems to initiate on-line capabilities such as command data processing, program generation and debug, word processing, graphics, and electronic mail capabilities, health monitoring, imaging for proximity operations, display and performance and trend data, and appropriate payload interface monitoring. | 132(C-4-32) |
| -04 The initial DMS design shall provide the following:
a. Control initiation and status indications to/from all DMS users and subsystems for SSP operations independent of the source.
b. Distribution of housekeeping (timing, state vectors, RF communication, acquisition-of-signal/loss-of-signal, moding and pointing information, etc.) data to the users. | 132(C-4-32) |
| -07 Computer output shall be in a form that is usable without interpretation or further analysis by the crew. | 131(p 398) |
| -08 Subsystem computers shall output either go/no-go or detailed information, as required. | 131(p 398) |

- 16 Provide remote terminal with linkage to main system computer, e.g., at workstations, window station, laboratories. 131(p 397)
- 17 Provide secure ground station interaction with main system's computer. 131(p 397)
- 18 The DMS shall employ common elements in the form of interface devices, subsystem data processors, and executive software overhead, distributed through all subsystems. 133(p 451)
- 19 Error Protection- Measures to protect against error and fault propagation, and diversity of location shall be fundamental parts of the distributed DMS concept to protect against the anticipated environmental effects. 133(p 451)
- 20 The DMS shall protect data by partitioning subsystems processing to individual, subsystem resident devices. The Optical Data Distribution Network (ODDNet) shall prevent unintentional radiation of Space Station data and preclude interference by intentional and unintentional sources. The DMS shall provide encryption/decryption techniques for protection of the RF link input/output interface with the Information & Data Management System (IDMS), to assure operation in a hostile environment. 133(p 452)
- 21 The IDMS shall provide time and frequency references, distributed to all subsystems simultaneously. The Network Operating System (NOS) time tags all subsystem I/O transactions using the distributed time and frequency reference to assure time correlation of all data. 133(p 454)
- 22 Facilities management shall be available to all subsystems and payloads. This service shall manage and sequence Space Station Information and Data Management System (IDMS) storage and access and station level data analysis and ODDNet management. In addition, this service shall provide station level configuration management including logistics, resource allocation, and scheduling data for the crew's use. Tutorials for refreshing the crew on procedures shall also be provided from this service. 133(p 455)
- 23 The DMS shall require minimal manual administrative support, thereby providing such automatic features as recovery from machine and user errors; up-load and down-load of data with appropriate ground facilities; elimination of redundant and insignificant data; and data partitioning and integrity protections. 133(p 455)

- 24 The DMS shall also provide multiple views of data; temporary workspaces for data manipulation; a natural language mechanism for online query from the MPAC's; and a higher order language interface for operations and applications usage. 133(p 455)
- 25 The DMS shall incorporate advanced data base management techniques, such as the use of the relational data model, which support data element types necessary to scientific, engineering process control and other tasks which must be supported by the IDMS. 133(p 455)
- 26 The DMS shall support a full set of geometric entities for use in the MPAC display of three-dimensional objects, animation, CAD, and two-dimensional graphical data representations. 133(p 455)
- 27 A distributed processing concept shall be used for the management of the ODDNet. Protocols and priorities may be preprogrammed either in the IDMS or a common module of the Subsystem Data Processor (SDP). Override of selected functions may be commanded by the Management unit or manually. 133(p 455)
- 28 Safety requirement for all software programs, especially those performing control or integrating functions, shall be designed to default in a predetermined safe condition. 159(pp 5.15.1)

OPERATING SYSTEM

- 29 The DMS shall support a user-friendly language for the man/machine interface. The language shall be capable of interfacing between man and machine for communications, display generation, monitoring, checkout and control during all phases of development and operations. 132(C-4-32)
- 30 The IDMS NOS shall consist of a set of common software provided to all subsystems to perform the distributed protocol, formatting, data handling, control, and display functions common to all subsystems as determined by the IDMS architecture. 133(p 453)

MEMORY CAPABILITY

- 31 Provide data storage, retrieval, and delivery services for the core system data. Short term storage shall be provided onboard and selected data can then be transferred to archival storage on the ground. This service shall provide rate buffering and data maintenance. Short term storage shall also be provided for selected audio, video, and communications data. 132(C-4-33)

- 32 Adequate mass storage capability shall be provided by the IDMS for the collection of station level status concerning subsystems, inventory, and proximity activities. General Space Station capacities, margins and limits for the purpose of records, trend analysis and distribution will be stored as needed. Periodically, stored data shall be downlinked to the ground for archival purposes. 133(p 454)

INTERFACE COMPATIBILITY

- 33 Provide an interface with space platforms and other robotic subsystems to support displays of remote sites, remote manipulations, and other unmanned proximity operations. 132(C-4-33)
- 34 Provide onboard experiment data and assessment capability in real time. 131(p 410)
- 35 Programs for hardware checks of interfaces & operating status shall not generate command signals which may activate or deactivate the item or system. 159(pp 5.15.4.1.2)

APPLICATION PROGRAMS

- 36 In addition to the following requirements, MIL-STD-1472C, or later issue, and Design Guidelines for the User interface to Computer-Based Information Systems, shall be used as the standard. 132(C-7-4)
- 37 The DMS software shall be capable of interfacing directly with software programs and the NOS to ensure access to the operational data base. 132(C-4-33)
- 38 Computer software capability shall be provided for the following: Scheduling, checklists, station systems diagrams and information, systems monitoring, science, troubleshooting, maintenance information, inventory, housekeeping, word processing, dedicated PI links, replacing paper reports, maps, horizon sensors, orbit, etc. 132(C-4-33)
- 39 Software shall be "user-friendly". 132(C-4-33)
- 40 Versatile software which can be easily changed shall be provided. 132(C-4-33)
- 41 Software system reliability shall be assigned priority. 132(C-4-33)
- 42 Provide a system capability to permit easy software modification by the flight crew without the need for software reverification. 342
- 43 Provide onboard planning aids for computer 342

generation of bar charts, time lines, and procedure sequences.

CANDIDATE SOLUTIONS

REFER. NO.

None

CRITICAL ASSUMPTIONS

REFER. NO.

None

* *An "ISSUE" has been defined for study to confirm or complete definition of this preliminary requirement.*

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